Renewable Energies for the South

New Support for Clean Energy Investment in Developing Countries

Edited by

Wolfgang Jung and Heinz-Peter Schmitz-Borchert

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Preface

At the beginning of the 21st century there are still more than two billion people in the world without access to electricity and basic energy services. "Energy poverty" impedes sustainable economic, social and environmental development of rural areas in developing countries. Large-scale diffusion of renewable energy technologies can help to overcome this situation. Major barriers are now beginning to be removed.

This volume is the result of an international symposium on 'Renewable Energies for the South', held at the Science Park Gelsenkirchen, Gelsenkirchen/Germany. It took place on June 5-6, 2000 with more than 200 participants from 27 countries. The conference aimed at enhancing the dialogue between the multiple groups and actors involved in the development, transfer and application of renewable energy technologies.

The following issues are covered in this book:

- technology needs and framework conditions in developing countries
- appropriate renewable energy technologies
- financing renewable energy investment
- capacity building and training programmes

We hope that this survey will help to step up worldwide efforts to move technology cooperation between North and South from strategy to reality.

Gelsenkirchen, February 2001

Wolfgang Jung and Heinz-Peter Schmitz-Borchert
Science Park Gelsenkirchen/Germany

Opening Session

The symposium was generously supported by the Ministry of Economic Affairs, Energy and Transport, Nordrhein-Westfalen/Germany. Additional sponsoring came from the German Minstry for Economic Cooperation and Development (BMZ), the Carl Duisberg Gesellschaft (CDG) and from Shell Solar Germany.

Welcome Address

Oliver Wittke

Dear Dr. Miller,
Dear Mr Hennerkes,
Ladies and Gentlemen,

I am very pleased to be able to stand in front of such a distinguished international audience. Solar energy has brought you to Gelsenkirchen. The boom in this technology is a very young development for our city - only recently, Gelsenkirchen has become a location for the production of advanced solar technology.

For many decades, Gelsenkirchen has been a city in which the production of energy is of great importance. The mining and processing of coal have been traditional local industry mainstays. Only a few weeks ago, the last mine was closed. With the production of solar cells we have again established an important branch of energy production in our city. Today, we realise that a solar factory can be the basis for new jobs. Presumably, some of you have experienced the same in your countries.

In the areas where the new technology is offered, designers are required who develop houses with solar modules as heating systems. Tradespeople are required for the professional installation and maintenance of the systems. Consultants are needed who know how solar technology is used most efficiently. In Gelsenkirchen, there are training programmes for tradespeople and engineers. Those who are unemployed are trained for one year to become "solar technicians".

In the field of technolgy production, there is great potential for Gelsenkirchen as well. The new solar cell factory of Shell Solar Germany could be the core of all of this. The Visitor Centre of the production site is an important supplement, as here, laymen and experts alike are able to get information about this environmentally friendly technology.

In addition, in Gelsenkirchen a housing estate was set up in which every house was equipped with solar collectors. This is the first one in the Ruhrgebiet and I am confident that many cities will copy our idea. You will visit this housing estate tomorrow afternoon. The school close to the solar housing estate was also equipped with a solar plant, as is the case for the Science Park, where we presently are. Plans are already underway for further housing estate projects.

Compared to the amount of buildings which are supplied with conventional power, this is not very much, but within the short period since solar energy has become of importance to Gelsenkirchen, the number of projects is considerable. I am convinced that there is a large potential for solar projects which we must discover and open. However, we must always consider the interests of power providers already here. I am also convinced that development towards solar energy will be made at a good pace.

From your schedule, I see that you have quite a considerable amount of work to do during your two-day stay in Gelsenkirchen. I hope that this conference will be of great benefit to you and your home countries. I wish you all an interesting stay with many new insights.

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North-Rhine Westphalia - A Partner for Clean Energy Strategies

Jörg Hennerkes

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Introduction

Ladies and Gentlemen, before introducing North-Rhine Westphalia as a partner for clean energy strategies, I would like to welcome you and convey the regards of prime minister Wolfgang Clement, and the minister for economic affairs, Ernst Schwanhold.

North-Rhine Westphalia's steps towards sustainable development

Exactly 28 years ago, in June 1972, the first World Conference on the Environment in Stockholm paved the way for the establishment of the United Nations Environment Programme (UNEP). In the following two decades, the environment – together with poverty and development issues – gained more and more attention on national and international political agendas, culminating in the 1992 United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro. The conference concluded with the approval of "Agenda 21", a global action plan based on the key principle of sustainable development. The "Earth Summit" sparked a still ongoing and often controversial debate on how to achieve global sustainable development. One of the major issues is the question of who has to act first.

In particular, the concept of a "common but differentiated responsibility", which was included in the Rio documents, is subject to a variety of interpretations. Industrialised nations tend to emphasise the need to get all countries – in both North and South – involved from the outset, so that global environmental goals can be achievable in the first place. On the other hand, developing countries point to the fact that the fifth of the world population living in industrialised countries is responsible for four fifths of global resource consumption and environmental degradation. The North should thus start to build sustainable economies and societies at home, before putting additional pressure on the developing world.

Being aware of this conflict, the state government of North-Rhine Westphalia took early action and formulated guidelines for its development policy in 1993, aiming at the implementation of the Rio agreements in general and "Agenda 21" in particular. Since then, the state government has consistently worked on integrating the idea of sustainable development and global partnership into different fields of state policy; that is, development policy, international policy, and European policy. In the remainder of this paper, I am happy to present you with a selection of current and envisaged activities in these fields.

New strategies and policies

Development Policy

The state government has established its development policy as a cross-sectoral activity. Chaired by the North-South Representative, an advisory board ("Eine-Welt-Beirat") was founded in 1996 covering all issues related to sustainable development. The membership ranges from scientific institutions, business associations and trade unions to churches, media, and NGOs focusing on environmental and development issues.

Local Agenda 21

The state of North-Rhine Westphalia explicitly supports local Agenda 21 initiatives, specifically through "Agenda-Transfer", a clearing mechanism targeted at sharing knowledge and learning from successful examples. One of the conclusions that can be drawn so far is that the local level appears to be perfectly suited to generate interest and active involvement in environmental and development issues. Participation of multiple stakeholders in projects that try to integrate social, economic and environmental concerns is much easier to organise if problems are at hand and participants know each other.

Research and Education

One key requisite of the transition towards sustainable development is a working knowledge of current problems and possible solutions. Due to the far-reaching nature of the goal, knowledge for sustainable development must be attained at all levels of government and in all sectors of society, down to the individual level. The challenge affects school and university education, as well as scientific research and training on the job.

The state government actively promotes the integration of the idea of sustainable development into (primary and secondary) school education. On the federal level, North-Rhine Westphalia contributed to a decision to put more emphasis on intercultural skills in the development of curricula. On the state level, the action plan "Environmental education in schools – a contribution to the implementation of sustainable development" was set up. Along the same lines, the state government helped to launch the pilot project "Agenda 21 in schools", which emphasises the interconnectedness of environment and development.

North-Rhine Westphalia contributes to capacity building in developing countries by providing opportunities to study and research at the state's colleges and universities. In 1998/99 more than 27,000 registered students were from developing countries. North-Rhine Westphalia has become a major hub for applied science in fields with specific significance for developing countries. This is an important element of the general strategy to internationalise research and education programs and to contribute significantly to international scientific co-operation.

North-Rhine Westphalia – The Energy State

North-Rhine Westphalia is Europe's most important energy region and the centre of Germany's energy industry. A significant share of the employment in the state's industry sector depends on clean, safe and affordable energy supply and use. It is thus in our own best interest to develop, deploy and disseminate clean and efficient energy technologies. This not only helps to save and create employment, but also to reduce resource consumption and environmental degradation – in the region and world-wide. In this sense, rational use of energy and other resources in the North is important to create the "environmental space" for economic development in the South and for future generations. NRW offers excellent conditions for the development, production and marketing of renewable energy and energy efficiency technologies. This potential builds on scientific, technical and organisational know-how, combined with a comprehensive problem solving capacity.

We intend to further develop these skills and capacities, accepting the challenges resulting from rapid globalisation of markets and accelerated structural changes in the economy. We will achieve this through a set of combined measures, aimed at strengthening economic performance and employment levels.

NRW State Initiative on Future Energies

As an important institutional measure, a new strategic forum was created in 1996 with the launch of the "NRW State Initiative on Future Energies". This initiative is a common effort of the three ministries for economy, science and construction. The initiative constitutes an offer to industry, small and medium-sized businesses, science and research, consultancies and engineering companies to co-operate in the development, deployment and dissemination of clean and efficient energy technologies. This involves the growing use of renewable energy sources, the availability of decentralised technologies, the expansion of combined heat and power generation, and energy conservation technology. So far more than 3000 experts have joined the 15 issue-specific working groups of the initiative.

One group works on international economic relations and offers support, particularly to small and medium-sized businesses in their effort to enter foreign markets and find business partners abroad. In this context, the economics ministry financially supports participation in international trade fairs, the organisation of workshops and conferences here and abroad, but also training programmes for experts from foreign countries. All this is aimed at creating a mutual understanding of specific needs and framework conditions, as well as appropriate solutions and fruitful cooperation.

NRW REN Programme

Specific projects are promoted through the programme "Energy efficiency and the use of renewable energy sources" (NRW REN Programme). Since 1988, when the programme was launched, more than 41,000 projects were realised with the help of grants and low-interest loans. The funding amounted to a total of 760 million DM, contributing to a total investment of more than 4 billion DM.

The NRW REN programme - Institutional Structure

Technologically outstanding projects were selected as "lead projects" of the programme:

- Europe's biggest solar cell factory in Gelsenkirchen. Operating since November 1999, the production capacity will reach 25 MW when the factory is fully completed. The use of highly advanced production technology aims at cost reduction, which is necessary to make photovoltaics more feasible, particularly for countries and regions with limited financing options.

- The world's largest building-integrated photovoltaic power plant at the Academy Mt. Cenis in Herne, a training institution of the state's ministry of the interior. The 1 MW (megawatt) plant, together with an innovative battery-storage system and a cogeneration unit fuelled by pit gas, is praised by engineers and architects world-wide.

- The biogas plant in Herten, demonstrating the large-scale integrated processing of 18,000 tonnes of organic waste per year into methane and high-quality compost.

- The new wind test field in Grevenbroich with the world's largest serial produced wind turbine with a capacity of 2.5 MW. The test field will help to assure and improve the quality of wind turbines for inland areas.

These, and other examples I could list here, demonstrate that it is technically feasible and highly attractive to deploy the most advanced technology in the various fields mentioned. These kinds of projects are supported by the "technical development" and "demonstration projects" areas of the NRW REN programme. Market diffusion of new technologies is supported by the third programme area of the REN programme through grants and low-interest loans for private investors and individuals. The combination of these three programme areas represents a unique support system for the development, demonstration and distribution of efficient and renewable energy technologies.

The various programme efforts have produced measurable success: Based on an analysis of the University of Münster, the turnover of NRW companies in the renewable energy and co-generation sector rose to 1.1 billion DM in 1998. At the same time the number of companies rose to 1120 and the number of employees to 3300.

On the national scale, NRW has the leading position in the use of photovoltaics, wind energy in inland areas and power generation from biomass. We are among the leaders in the use of solar thermal energy for water and room heating. Just recently, in April 2000, we launched the "fuel-cell competence network" with the ambition to become an international leader in this extremely promising field of technology.

Complementing Measures

The NRW REN programme offers more than just the financial and institutional support

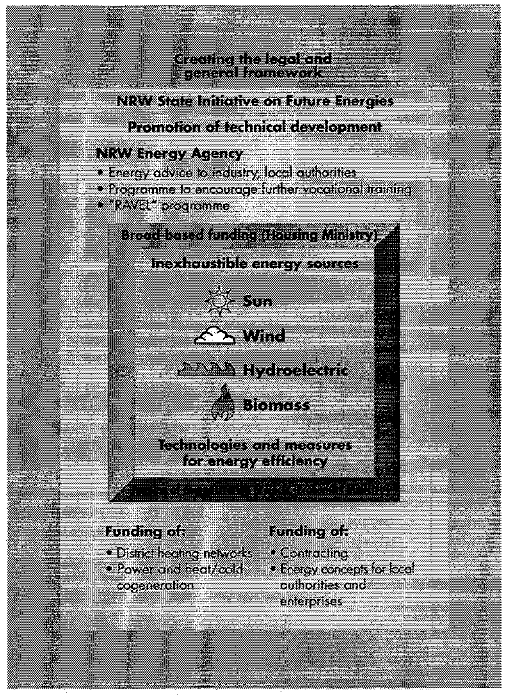

Figure 1: The NRW REN Programme - Institutional Structure

described above. It also engages in the dissemination of information and the education of key parties. For that purpose, a whole set of additional institutions was created in the context of the programme:

- The NRW Energy Agency offers free initial technical and economic advice particularly for small and medium-sized enterprises and local authorities. Furthermore, the agency promotes training measures for architects, engineers and workmen as part of the REN sub programmes "Building and Energy" and "RAVEL" (efficient use of electricity);

- the NRW Consumer Centre offers advice for individuals and launches high-profile campaigns in order to mobilise the vast energy saving potential in private households;

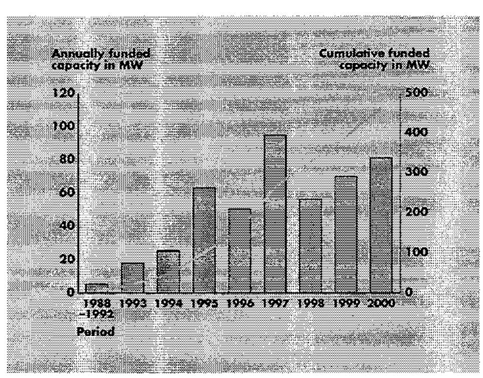

Figure 2: Wind generation: installed capcity

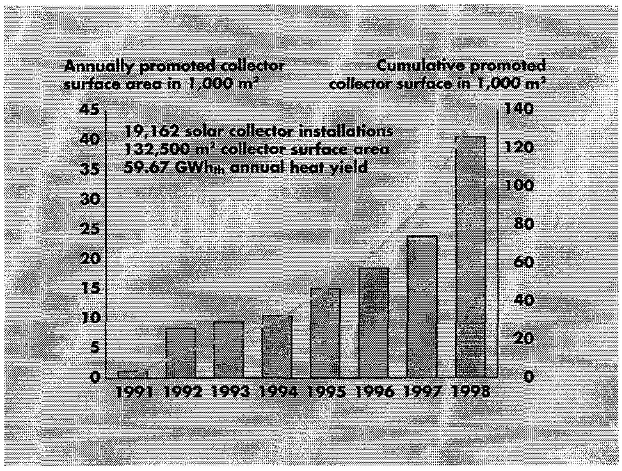

Figure 3: Solar collectors for water heating: installed capcity

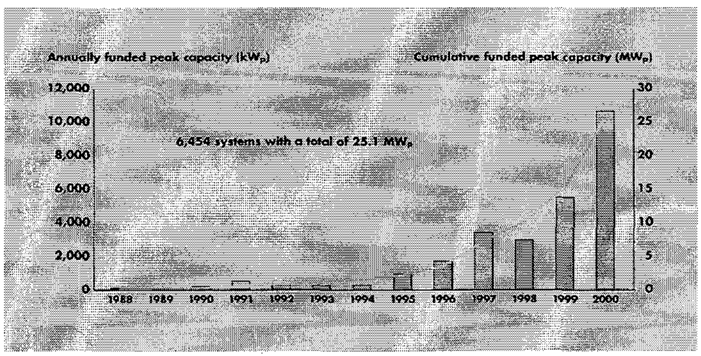

Figure 4: Photovoltaic Systems: installed capcity

- the Project Office "Energy, Technology and Sustainability" at the Research Centre Jülich gives support to the state authorities in implementing and reviewing the various projects within the REN programme;

- the Working Group on Solar Energy ("AG Solar NRW") co-ordinates state funding for research and development of renewable and efficient energy technologies;

- the Wuppertal Institut for Climate, Environment and Energy is an international think tank offering scientific advice to multiple players world wide;

- the clearing house for wind energy is responsible for all problems related to grid-access.

Conclusions

The state government of North-Rhine Westphalia is determined to initiate and support the processes necessary to achieve sustainable development - in North and South. We see ourselves not only as an important industrial region in the middle of Europe, but also as a responsible and reliable international partner. So far, co-operation projects of the state government have focused on specific countries in South America, Asia, Africa and Eastern Europe. Beyond that, overseas projects of NRW development NGOs are explicitly welcomed and supported by the state government.

International interdependence will be even more important in the future. Important political goals will become achievable only through

Plant technology	Number of projects	Primary energy saving (GWh) End-user energy factor Electricity = 2.883 Heat = 1.112 – Substitution method –	CO_2 reduction (t) compared to electricity mix (GEMIS): 1 MWh_{el} ≙ 0.575 t CO_2 for end-user energy, heat in accordance with mix (fuel oil, gas, district heat, electricity, coal, wood): 1 MWh_{th} ≙ 0,290 t CO_2
I Energy efficiency			
Heat recovery plants including condensing boilers	7,243	3,391	883,534
Measurement & control systems	1,023	5,712	1,488,985
District heat exploitation and distribution	294	36,210	9,256,663
Subtotal	8,560	45,313	11,629,182
II Regenerative energy sources – plant technology			
Bio-gas/landfill gas/ sewage gas systems	288	17,072	3,407,245
Hydroelectric power stations	133	2,941	586,500
Wind turbines	918	30,894	6,270,000
Solar cell installations	6,454	814	162,380
Solar collector installations	23,745	1,651	427,912
Heat pumps	1,364	364	63,180
Subtotal	32,902	53,736	10,917,217
Total	**41,462**	**99,049**	**22,546,399**

Figure 5: Funds and benefits allocated by REN

transnational or even global co-operation. Human dignity, social justice, economic prosperity and equity, protection of the environment, the rule of law and democracy – all this cannot be achieved through isolated activism, but only through co-ordinated action of all groups of the emerging global society. Accepting their special responsibilities formulated in the documents of the Earth Summit, the industrial nations of the North have to engage actively in that process. North-Rhine Westphalia is doing so, and is determined to continue doing so. With this in mind, we will evaluate and further develop our policies and measures on a permanent basis. We are ready to take advantage of the opportunities offered by globalisation, and – at the same time – help to mitigate its negative effects.

This conference is an important contribution to that agenda. I wish you two interesting days of worthwhile discussion here in Gelsenkirchen. Thank you.

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Clean Energy Technology Transfer - A Win-Win Strategy

Alan S. Miller

Introduction

It's my great honor to participate in this extraordinary event in such a perfect location on World Environment Day. I am here on behalf of the Global Environment Facility, the leading international financier of renewable energy in developing countries.

It is instructive to be in North-Rhine Westphalia, the leading German state, and perhaps the single leading sub-national agency supporting renewable energy anywhere in the world. Coming from the United States, I'm accustomed to believing that the US has the best of everything. With respect to renewable energy, we view California as the leader. But after listening to the Undersecretary's presentation, I will inform my American friends that they have much to learn from what is taking place in Germany. North-Rhine Westphalia is or may soon be the global leader and model.

Challenges faced by renewable energy

Working in the field of energy, one is accustomed to the metaphor of a "level playing field", or of an "open market competition". It has been said, since perhaps the first oil crisis, when governments began to take renewable energy seriously, that if only renewable energy could be put on the same basic economic status as other energy sources, it would be able to succeed.

Much of what we have learned and are still attempting to establish in the political process is that this metaphor or mental framework is really not correct. A level playing field implies that, like a horse race, society is indifferent to the winner. If you're backing a particular horse, you care a lot, but society at large will take its tax revenue at the end of the day and won't really care which horse wins. But we care a great deal about who wins the energy race, particularly from the standpoint of our global future. From the standpoint of the human race, renewable energy has to win. It's the only way we all have a future.

But for now, let me simply reiterate what all of us know, in such an expert audience and gathering, but sometimes don't want to recall: what renewable energy remains up against. The challenges and barriers to establishing renewable energy as a significant, much less a primary source of global energy services, are great.

The worldwide energy system that exists today is the product of investments over more than a century, amounting to trillions of dollars, which have produced among the most efficient, largest scale and most successful economic enterprises in the history of the world. These are, of course, the major multi-national oil companies, the electric power companies, and broadly, the fossil fuel industrial system that exists.

While we talk about a market, these fuels constitute among the most regulated sectors of every economy, despite the ongoing process of privatisation and increased competition taking place at a rapid rate in the industrialised world and in many developing countries. The system is the legacy of subsidies, which in the United States alone have been estimated well in excess of $100 billion. If one focuses on nuclear power as one example, the subsidy can be measured as a non-trivial percentage of every kW·h. It is a sector that has been the subject of government intervention and support in almost every conceivable form through tax policies, government mandates, research and development, and linkages to military and defense policy.

When the conventional energy system is disturbed, countries go to war. There are, to say the least, few higher basic priorities within the economic and political system. Our "modest" objective is to radically change it. So it should not come as a surprise in the almost three decades since the first energy crisis that we have made modest progress, but that we still have a long way to go.

In that context, the provision of renewable energy sources to developing countries has, in the past five years, taken on an extraordinarily higher level of political, technological, and economic significance. Renewable energy – this modest and still nascent set of technologies – is being viewed as a solution to climate change, as a strategy for alleviating global poverty, and as a means of spurring moribund economies in many developing countries. We have given a very small child some rather heroic adult objectives. Still maturing, and often early-stage, technologies are being asked to take on the objectives that very well-developed and mature technologies have been unable to accomplish. In that long – and likely to be lengthy – process, the Global Environment Facility is still a relatively modest initiative, if the most significant yet, in attempting to spur the role of renewable energy in the developing world.

Introduction to the GEF

Let me briefly give you what I sometimes refer to as "GEF 101". Although I live it every day, I'm constantly reminded that it is a system that is not well-known in most of the world.

The Global Environment Facility was first conceived of within the World Bank, prior to Rio in 1991, as a dedicated financial system to support the developing country costs of participation in global environmental agreements. If one thinks back to 1991 and '92 and the spirit of Rio, it was a time of remarkable political commitment and optimism, about bridging of North-South divides in a spirit of co-operation to address common global problems. Two major international conventions emerged from Rio. One addressed climate change, and the other biological diversity. In both of those agreements, the need for some fairness to developing countries was recognised. Provision had to be made so that those countries would not incur a development penalty in order to participate in those conventions. The notion was of a dedicated fund to pay the added or "incremental" costs of global benefits. Benefits would accrue to the world at large, rather than domestically to countries in return for their efforts. It was a concept first applied in the international agreement to protect the ozone layer, which created the first dedicated international environmental fund in 1990 – a fund that continues separately from the GEF.

The donors, if rather nervously in some cases, agreed to the demand for such financial assistance. At the time, there were estimates that the adequate level of funding for this global agenda would require new commitments and additional resources in excess of $100 billion per year – the figure published in Agenda 21. That level of resources, needless to say, was not forthcoming.

In the first period of the GEF pilot phase, the donor countries committed $1 billion for three years. This compromise was greeted with support, but with some reluctance, because at the time, the GEF was still part of the World Bank – an institution which is sometimes viewed with suspicion by its client countries.

Three years later, in 1994, a new, restructured GEF was realised which continues today. The restructured GEF exists under a separate international legal agreement, with its own system of governance – a 32-country council, more or less evenly divided politically between donor and client countries. However, out of donor concern, the GEF is not a new institution. It provides funding, but it does not develop or implement projects.

Funding is provided through three primary implementing agencies: The World Bank, the

UN Development Programme (UNDP), and the UN Environment Programme (UNEP). Every three or four years its budget must be reauthorised, reflecting a continued evolution and political re-negotiation. At the current time, the second GEF under its restructured form is operating under a total budget of approximately $2,6 billion for four years.

Let me turn now to the subject of most obvious interest and relevance, as the basis for further discussion today. That is the GEF role in support of renewable energy, and the lessons we think we have learned, as we will no doubt hear many more focused and expert opinions over the course of the day from this very impressive, internationally diverse group of speakers.

GEF and renewable energy

Renewable energy is, by some measures, the largest single commitment within the GEF, remembering that our activities encompass biological diversity and some elements of international marine protection. Including the pilot phase within the World Bank – that is, going back to 1991 – the GEF has made commitments of over $500 million for almost 50 projects in about 30 countries. The total project investment – private and bilateral – involved in these projects now exceeds almost $3 billion US. Thus, the GEF commitment represents about a fourth of all of our activities. This, mind you, is only our specifically renewable energy related activity. Energy efficiency and other climate-related projects would roughly double this amount, so the total GEF commitment for climate change projects has been on the order of roughly $1 billion, to date.

This funding has been provided through two basic strategies that frame everything we do. The first is removing barriers for commercial or near-commercial renewable energy technology. A typical example would be small solar household systems in rural areas, which, on a life-cycle basis, provide energy services at roughly the same cost as kerosene, car batteries, and other lower quality fuels being used in areas not served by electricity – areas where 2 billion people worldwide are not connected to an electricity grid. The other basic strategy is cost reduction and risk-sharing. These projects address promising but still costly technologies or applications of technologies. Examples would include biomass gasification and solar thermal powerplants. For example, a project we are doing in Brazil seeks to gasify "bagasse" as a fuel for power generation. Or, more recently still, we funded a project using photovoltaics at water-limited hydro sites, thus allowing the use of photovoltaics in a reliable, grid-connected form. It is a concept that is not yet competitive, but with modest further cost reductions, we believe can be.

As yet, unfortunately, a still small number of these 45 or so projects have actually been completed. One of the frustrating realities of the international system – I hope it's not as true of North Rhein Westfalia – is how long it takes to get projects approved and implemented, often on the order of at least three years and sometimes in excess of five. This is a standard that is clearly not consistent with most private commercial activity.

Nevertheless, from the context of those that have been completed and those that are in an advanced state, we have already learned quite a lot. We are attempting to learn from these lessons and incorporate them as we move forward. Let me summarise the five lessons that I would say are most relevant to the discussion today, and as a basis for contrasting and comparing with some of the national experiences that I know will be addressed over the course of this morning.

- Although much of the debate about renewable energy technologies focuses on their cost and performance, in the field, the technical performance of these units has been almost uniformly excellent.

They have done what they have been asked to do. We have seen no rash of failures or difficulties in providing maintenance. Indeed, almost consistently, they meet or exceed all the performance expectations. This is despite a wide variety of international sources for the supply of these systems – some manufactured locally, some provided by companies in Germany, the United States, and elsewhere.

However, in achieving this high level of performance, a great deal of attention has been necessary to assure product quality. In almost every case, some long involvement has been necessary to establish standards and quality assurance at the national and local level. This is a process that is difficult to accelerate. People have to be trained, standards have to be addressed to local conditions, and ultimately, if you bypass these steps, you will pay a price. We certainly are aware of many previous bilateral projects that have produced technically unsuccessful solar energy and renewable energy systems.

- Overwhelmingly, the single greatest need that our projects are asked to address is financing, and more specifically, the absence of rural credit.

In a meeting at the World Bank last year, one of the small solar companies active in the Caribbean described waking up that morning to a commercial on television, telling him that he could walk into a car dealership, fill out a one-page form, put no money down, and drive away in a $25,000 vehicle. In contrast, the reality for most of the world, and certainly for the 2 billion people without electricity, is that if you want a $500 piece of renewable energy equipment, you need $500. Borrowing that $500 is only possible at an extraordinarily high rate of interest. That is an extremely challenging problem to overcome.

We have more than 20 different projects that try to address the rural credit issue in diverse ways, and there is no obvious right answer. We are working in Bangladesh with micro-credit systems that attempt to provide people at the local level with credit for entrepreneurial activity applications of renewable energy. We are providing credit guarantees for solar businesses to be able to borrow from standard commercial banks.

We are already seeing that it is a risky business. The single largest rural renewable energy project approved by the GEF Council was to have been in Indonesia. It was to provide credit through rural banks to allow people to borrow up to $500 for renewable energy systems. The problem was that, the Indonesian economy subsequently collapsed and devalued the local currency. Many of the rural banks went bankrupt. With the demise of those banks was the demise of the project – it had to be canceled. It is indicative that even the most carefully thought-out and designed project is ultimately dependent on the adequacy, credibility, and continued existence of the commercial sector in the companies in which we seek to do business.

- In many of the countries that we have entered and worked in with the World Bank or regional banks, we have been told over and over again by multinational companies and local companies that our greatest contribution has not been the money that we put in. It has rather been the legitimacy, credibility, and impact on local governments that the entry, particularly of the World Bank, can provide.

This has been such a powerful effect that there are instances in which the specific objectives of a project have not yet been achieved, but the market for renewable energy has already taken off in advance of our investment. In a limited sense, one could almost say that the project failed, but the market succeeded. Let me give you an example.

In Costa Rica, more than five years ago, the GEF committed to support wind energy. The project was to have been the first of its kind: an extremely promising wind site. It came despite the reluctance of the national utility company, which was not enthusiastic about the idea, and it required significant investment in wind resource assessment and data. As a consequence of the Bank presence and the discussions with the utility, a wind energy business has now taken off in Costa Rica, even though our specific investment has yet to be completed. There are several other instances of that phenomenon.

- Regulatory and policy issues are almost always important in our projects, particularly for those projects on a larger scale.

Some of our projects are as small as a village or an individual demonstration. But increasingly we are seeking to frame our projects more ambitiously as programs for sector reform and national, provincial, or state renewable energy development. To accomplish these more ambitious objectives, it is almost always necessary to engage the government in a dialogue about such issues as import duties, which can be as high as 100%, and power purchase agreements, which can make it impossible to install grid-connected technologies such as wind energy. As mentioned earlier, more careful negotiation over standards for quality assurance and training is also essential. To a great extent, this market conditioning has still not taken place. Without it, it is often impossible to promote market development on a large scale.

At a village scale, and at the level of the individual entrepreneur, it is impressive how much is being done despite these barriers. Many small businessmen in rural Kenya are successfully on their own – without international subsidy and despite high tariffs – selling PV systems. But to frame a broad sector approach, it is impossible without addressing the sometimes extremely contentious political issues.

- We are seeking to undertake our projects in ways that can create successful conditions for the private sector.

The scale of GEF financing and all international public support for renewable energy will never be sufficient to create a lasting, sustainable, and rapidly growing renewable energy market. We increasingly believe that the most important thing that our limited funding can provide is a basis for risk-sharing that leads as quickly as possible to a recognition that renewable energy is a competitive source of energy services that is not dependent on subsidies. Indeed, private companies have told us that if our projects are going to subsidise markets, they would in many cases rather we didn't get involved at all. A market, once subsidised, is extremely difficult to restore to a non-subsidised state. We are thus increasingly seeking to use our funds in risk-sharing approaches – in contingent financing or guarantees, or to provide technical assistance to small and medium enterprises. I was pleased to hear similar strategies are being pursued by the state of North-Rhine Westphalia.

These are complex programs which we could discuss in greater depth over the course of the day, but I think the basic message is clear. Let me now very briefly attempt to note several of the directions that GEF is pursuing, by looking ahead and attempting to learn from some of our experiences over the past five years.

GEF and the future

We are, as noted earlier, seeking to frame our support in larger, longer term, and more ambitious ways. In co-operation with the World Bank, the GEF last year approved a new renewable energy partnership. It is a concept that will allow us to provide funding as a combination of loans and grants totaling several hundreds of millions of dollars in a single approved Bank/GEF program. Such funding can be provided over a much longer term of ten years or longer, and it will be dispersed in branches; that is, perhaps, in three or four separate commitments of funding that allow adapting program design to on-the-ground experience, rather than assuming that the entire financial commitment has to be approved at one time at the outset of a project (more typical of World Bank practice). Such renewable energy programs will be sectoral, framed in a partnership with client countries, and they will define performance goals that may, for example, include percentage of electricity to be provided from renewable energy technologies.

The first such design was approved in a project with Uganda in May, and we hope some time next year to have a renewable energy partnership with the Government of China that would be the single largest GEF project ever put forward.

Secondly, in order to accomplish our objectives, we think we need a wider range of partners. It is a recognition that as large and accomplished as the World Bank, UNDP, and UNEP may be, they are simply inadequate to the task. We have already received political approval to expand our relationship with the regional development banks, and the Asia Development Bank in particular has already stepped forward with several renewable energy projects. We expect many more. We hope over time that the other major regional banks will provide a similar level of commitment.

A final point on directions is that we see an extremely pressing need to engage in a much closer dialogue with recipient countries. The original vision of the GEF was that we would operate at a level removed from our client countries. The GEF process would exist through its implementing agencies: the Bank and the UN. But increasingly, that narrow channel has not been sufficient. We have recently begun conducting week-long workshops in roughly sixty-five countries, starting with South Africa and Vietnam and continuing worldwide over the next two years.

Conclusion

I started my remarks with a note of pessimism, in recognising the challenge that renewable energy is up against. Let me close in a more optimistic way. It is simply my personal view, and not an institutional one.

Renewable energy technologies are consistent with, and inevitably are going to respond to where the world is going. It is renewable energy technologies uniquely that can meet global needs, trends, and capabilities. This is so because they are decentralised and can be tailored to local needs and circumstances, because they are based on the most sophisticated technologies and manufacturing processes. At the same time, they need depend on limited materials, imports, or specialised expertise at a local level. Finally, it is so because they anticipate the growing demand for environmental quality and respond to the increasing evidence that air pollution is an extraordinary public health hazard at levels much lower than had been previously understood.

What we do in the next five years will matter a great deal, I believe, in how rapidly renewable energy is adopted and penetrates into the developing country markets. It will happen, but it may take much longer, and it may reach the poorest parts of the developing world particularly much more slowly if we are not up to this challenge. The GEF is only a small contributor, and I look forward to hearing your comments and observations about how we can do our job and help you in doing yours much better.

Thank you very much.

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Session I

Technology Needs and Framework Conditions in Developing Countries

Rural Electrification in Remote Areas of China- The Brightness Programme

Ma Shenghong

Introduction

For the last three years China had a very large project for rural electrification. As such, the figures for each province are changing. Also, some of the provinces in the eastern part, which are mountainous areas, the local government has a policy of brining people down to better places, where electrification is happening, so these figures are changing. Hopefully, in two or three months, we will have detailed figures from each of the projects.

Electrification in rural China

In Mongolia now there are still thousands of villages, with over 300,000 families that aren't electrified. In the Xinjiang and Gansu provinces, and in Qinghai among others there are also huge numbers of households which aren't electrified. Fortunately, in those regions wind and solar resources are relatively good. Logically, the most feasible way to electrify those households is by using wind and solar resources.

In the many grasslands, the situation is a different problem. We have people living in the villages. But, many herdsmen can't concentrate in a village, so they have to live further out. The distance between families is the dominating factor. Certainly, this makes it more difficult to electrify those people by grid.

People using the wind and solar energy is a good solution. Since 1990, we have worked with the help of the German government on a co-operation project in inner Mongolia. This project started with resource assessment, joint development of the system, and a major demonstration in Inner Mongolia. We have installed intelligent wind/diesel power, as well as wind/diesel/battery village power systems, and PV/battery/diesel systems. We have also installed many wind and wind/PV hybrid systems. The oldest wind/diesel/battery system was installed in 1994. It is still working in a very satisfactory way.

We have installed 26 village systems, and hundreds of home systems. Those systems have been running for five to six years, in a very good way. People appreciate them.

Hardware used in Inner Mongolia

A typical wind/diesel/battery system consists of two sets of 5 kW machines, from North Rhein Westfalia, from the Venus company. The backup charges the batteries so that with the inverter, the isolated grid can get a continuous power supply. Wind towers can be as high as 19 m high tower, with a diameter of 6 m. This charging controller has its distribution box locally manufactured.

The battery bank has 48 pieces. The capacity, depending on the size of the village, is 800 A·h to 1400 A·h. In village systems, the inverter has a master and two slaves, so it can run three phase 380 V power, and drive motors for production.

We have also developed the hybrid systems, which are unique in Mongolia, and in China. In Inner Mongolia, unlike other provinces in inland China, the wind in summertime is not very strong. But, people still need power. For this, we developed a very popular wind/PV hybrid system. It uses a locally made 300 W wind charger with 100 or 150 W PV modules, depending on wind conditions and the load situation. Normally, these systems can drive a deep freezer, a colour TV, several light bulbs, and a washing machine. People like these systems very much. Such systems in China today cost about 13.000 Yuan. In Inner Mongolia now, most people wish to have such a system; it is a very good combination for local conditions.

Evaluation of the system

If energy consumption is higher using wind, compared with other options for energy systems, such as diesel or grid connection, we know wind energy is good. If we supply the village with continuous 24 hour supply, wind always has better economical features. If the distance to the grid is less than 15 to 20 km, we have to consider whether to use the grid instead of a renewable energy system.

For off-grid systems, if the wind is good, then the wind is normally the best solution, then PV, then hybrid, then diesel. This is why many people are asking for and looking for such systems.

The technical viability is convincing. The Chinese government will sponsor the so-called "Brightness" program. It is a program to supply 23 million people in remote areas with electricity using wind and PV technology by the year 2010. One hundred watts of power per capita is to be installed, which is one third of the average power consumption of people in that area. Meanwhile, frontier stations, relay stations, rural service stations, oil pipeline maintenance stations, and remote rail signal stations will also be supplied.

Plans for the Brightness program

The Brightness program will be implemented in different phases. First, supply power to about 8 million people, 2.000 villages, 100 border stations, and 100 microwave stations for whom it is not practical to extend the grid. In addition, the first phase is necessary to establish a solid foundation for further development of the program. The Brightness program is probably the first program on a national level. In Inner Mongolia and China that wind chargers and solar systems have been developed for many years, but these programs were on a provincial level.

Results of the first phase of the program will be

- About 1.7 million home systems, and 2000 village systems, and 200 station systems installed.
- The financing channel of the central and local governments will be involved, and a realistic financing mechanism established and working.
- A systems supply industry to provide the necessary hardware in high quality, at reasonable prices will be set up.
- A complete and effective service and distribution network, with marketing marketing mechanics established.
- A technical training system for different levels of training installed to train local technicians and engineers.

I will explain why these results must be reached in the following pages.

We focused on five provinces first: Inner Mongolia, Tibet, Gansu, Xinjiang, and Qinghai. There are 6.5 million households to be considered. Fortunately, these provinces have very good wind and solar resources. It has been proven with many years of practice that it is feasible to supply power using wind and PV technology. In recent years several demonstrations have shown success, so local people appreciate that such solutions are practical.

The Brightness program will organize a large-scale project. We want to reduce the costs for production and of distribution, so people will be able to buy wind and PV systems. Certainly in doing so, service charges will also be reduced.

Barriers to the Brightness program

There are still some barriers to the Brightness program.

- Capital investment costs of wind and PV systems are still high. It is difficult for most of the users to pay all at once.
- Proper quality testing and certification programs to ensure proper hardware and installation is not in place.
- Sales and service are not regulated.

- The reliability of the systems are not assured.
- System suppliers are too far away from the end users.
- Sales costs are too high, people are reluctant to give the final payment, and orders are too small, and the market is unstable as a result.
- Difficult to reduce production costs.
- Industry is reluctant to invest to develop new technologies.
- Technical level of the users is relatively low. They do not know how to properly use and maintain the systems, and sometimes cause problems and damage the systems.
- Many users in remote areas are used to relying on government subsidies. They are not yet familiar with the market economy. It is necessary to actively develop a project of income generation using wind and PV technology.

Goals of the Brightness program

We picked a measure for our project design.

- To create and apply credit, leasing or barter trade method, in accordance with the users situation.
- To strengthen foreign co-operation to get outside support, such as that of the GEF.
- To establish a system quality test and evaluation center for certification. This is going to be installed in the Institute of Electrical Engineering at the China Academy of Sciences, invested in and supported by the SDPC. All the systems used for the Brightness program must be tested and certified.
- The project Prioritor shall build up a complete dissemination of events, and provide a satisfactory sales and service. This will solve the remoteness problem of manufacturing and convince the end user with regards to quality and maintenance, as well as dramatically reduce sales costs.
- Effective training in different levels, to increase awareness in the end user.
- Agreed markets are going to be formed by the Brightness program. The qualifying industrial enterprises will get large orders, thereby dramatically reducing the price. Meanwhile, SDPC plans to support the qualified industries to raise their technical level and production capacity.
- To develop and install various payment methods, such as credit, to match with other market mechanisms. Unreasonable subsidy policies shall be canceled.
- To support income generation projects using wind and PV technologies.

The Brightness program has already started, with the pilot phase in three provinces. The pilot phase will take place this year and next; two years total. Five thousand hybrid systems will be installed in Inner Mongolia. Each will have a 300 W wind generator. 3.500 will have a 100 W PV generator in the hybrid combination. The remaining 1.500 will use a 150 W PV generator. This will be concentrated in three Banners, or counties, in Inner Mongolia.

The follow-up to the pilot phase will involve installing 10.000 home systems and 100 village systems.

Electrification in other provinces

In Gansu, the total capacity installed will be PV, as the wind isn't good for power generation. 320 kW PV is planned to be installed over two years.

Tibet certainly has special conditions. There, they will concentrate more on village systems. Each system will be 5 to 7 kW, and the total installation will be 50 to 60 kW.

For the pilot phase, we hope to install a complete distribution network, and training program, and also offer the industry better market scales, and also to get experience from these pilot projects, particularly how to finance them, focusing on installing a credit system so people can pay for systems over three to five years.

Conclusion

Already, there are seven intended suppliers, providing samples for testing in Inner Mongolia in the field. I'd like to express our thanks to the North Western Government, which has supported the feasibility study in Inner Mongolia, for the many industrial co-operations it has enhanced.

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Annex

Pilot Project

It is necessary to carry out a pilot project prior to other projects of the program due to the complicated situation. Special attention shall be paid to the implementing mechanism and the monitoring system during the pilot project. The experience shall be very valuable to "Brightness Program".

The pilot project is designed as follows:

Objective of the Proposed Project:

To Develop a Project Execution Mechanism and Monitoring System

Results of the pilot project will be:

1. An effective quality guarantee system is developed and installed

2. Scenario for setting up distribution net and regulations are developed

3. Financial scheme of B.P. is developed and applied

4. Monitoring System of B.P. is developed and installed

5. Training System of B.P. is developed and installed

6. Other appliances powered by RE system are introduced to the users

The pilot projects started in March , 2000, it is planed to complete the projects by June, 2002. The planed installation is detailed in table 4

Area	Province	Village not Electrified	Households not Electrified	Village Systems	Home Systems
	Gansu	1,946	696,718	120	150,000
	Qinghai	774	100,000	50	15,000
	Inner Mongolia	1,383	535,608	120	100,000
	Tibet	7,446	454,200	100	80,000
	Xinjiang	1,732	300,416	120	100,000
	Other Provinces				
Northern China		911	176,865	170	80,000
	Hebei	245	12,286	50	30,000
	Shanxi	666	164,579	120	50,000
Northeast China		687	28,358	180	30,000
	Liaoning	155	7,774	80	10,000
	Jilin	0	0	0	0
	Heilongjiang	532	37732	100	10,000
Eastern China		11,560	756,122	400	400,000
	Shandong	0	0		
	Jiangsu	0	0		
	Zhejiang	285	17,122	100	30000
	Anhui	6,600	398,000	150	100,000
	Fujian	1,100	55,000	100	50,000
	Jiangxi	3,575	286,000	50	100,000
Middle & Southern China		35,103	2,102,523	360	510,000
	Henan	5,300	320,000	60	60,000
	Hubei	1,900	168,923	60	90,000
	Hunan	19,500	1,170,000	60	100,000
	Guangdong	2,333	140,000	100	70,000
	Hainan	6,070	303,578	60	80000
Southwest China		53,410	3,174,325	280	210,000
	Sichuan	19,670	1,170,000	60	50,000
	Chongqing	3,160	190,000	20	30,000
	Guizhou	3,280	164,325	50	30,000
	Yunnan	20,000	1,200,000	60	100,000
	Guangxi	7,300	440,000	90	100,000
Northwest China		2,237	566,451	100	105,000
	Ningxia	1,090	54,501	20	5,000
	Shanxi	8,530	511,950	80	100,000
TOTAL		124,572	8,891,586	2,000	1,780,000

Table 1: Preliminary Plan for the First Phase of the Brightness Program

Investment for	**Total**	**Payment of Users**		**Local Grants**		**Central Grants**		**Foreign Grants**	
		Money MY	%	Money MY	%	Money MY	%	Money MY	%
Distribution/ service net	124			74	59.7%	20	16.1%	30	24.2
High Consumption HS(20%)	4,545	4,294	94.5%	136.35	3.0%	0	0%	115	3%
Middle Consumption HS (45%)	3,520	3,176	90.2%	176	5.0%	52.8	1.5%	115	3%
Low Consumption HS (35%)	894	681	76.1%	71.52	8.0%	26.82	3%	115	13%
Village System	890	475	53.4%	200	22.5%	90	10%	125	14%
Station System	32	9	28.1%	8	25.0%	15	47%	0	0%
Total	10,005	8,635	86.3%	666	6.66%	205	2%	500	5%

Table 2: Projected investments

Component	unit	quantity	unit price(T Yuan)	Value(Mio. Yuan)
PV module	KW	106,000	35 -38	4,000
Wind charger	KW	240,000	10 - 16	3,000
Charging contro	ller kVA	355,000	3.5 - 7.5	230
Inverter	kVA	231,000	0.1 - 7	320
Battery	mWh	2,200	650 - 70	0 1,500
Total				9,050

Table 3: Requirement and Value of the Main Components

Province	Main systems	Quantity	In 2000
Inner Mongolia	Hybrid home system	4000	500
Gansu	Small PV home system	12500	4000
Tibet	PV village system	8	4

Table 4: System Installation of the Pilot Projects

Renewable Energy Strategies in India

N. Uttam Kumar Reddy

Introduction

The twenty-first century has dawned; with it the third millennium. This is indeed a significant milestone in human history and an occasion for all of us for reflection and change. The model of development followed so far has relied excessively on consumption of fossil fuels, and this has endangered the biodiversity and the ecology of the earth. On this World Environment Day, I think it's our duty to resolve that we should leave the earth, if not in a better state that what we came into, then at least at the same state as we came in. It is against the backdrop of increasing environmental degradation where, around the world, there has been an increased emphasis on renewable energy. If the current interest in renewable energy products gets concretized, the twenty-first century can be expected to be as profoundly shaped by the move away from fossil fuels as the twentieth century was by the move towards them.

Renewable energy resources in India

Renewable energy, which appeared to be no more than a bright idea some hundred years ago, may remain the only solution one hundred years later. The many positive signs in this direction all over the world, in developed and developing countries, there is an increasing interest in renewable energy. Carbon-free technologies which do not rely on fossil fuels are evolving from a stage of experimental curiosity to one of commercial esteem. All these developments are a good background. I will now present the renewable energy strategies in India.

India is generously endowed with renewable energy resources; solar, wind, biomass, and small hydro. These are widely distributed across the country, and can be utilized through commercially viable technologies to generate power.

Increasing use of these sources will be instrumental in simultaneously achieving environmental objectives. Renewable energy technologies fit well into a system that gives due recognition to decentralization and local participation.

India is the only country in the world to have an exclusive ministry for non-conventional resources. We have a focused approach to put renewable energy on the fast track. We are implementing what is probably one of the world's largest programs on renewable energy, covering the entire spectrum of RE technologies.

Current energy use in India

In the objectives of the program are both supplementation of power from fossil fuels, and to provide decentralized renewable systems in far-flung areas. The contribution of renewable energy to the total power-generating capacity in India is about 1600 MW. This is just 1,5%. Considering that the potential is over 100.000 MW, the utilization has been marginal so far.

India's energy development program has been put to sever pressure with the ever increasing demand-supply gap and mismanagement of resources, coupled with a non-uniform growth curve. Fundamentally, there is an increase in demand for energy due to:

- rapid industrialization.
- growing population.
- constraints of financial resources for enhancing this infrastructure facility.
- limited resources of coal and fossil fuels.
- burden on foreign exchange due to increasing imports.

The Indian energy policy now focuses on rapid development of all forms of energy, both conventional and non-conventional, promoting energy conservation and efficient management of demand, environmental conservation and sustainable development, development of decentralized systems based on renewable resources, particularly for rural areas.

The total installed power generation capacity in India is presently about 90.000 MW, and includes thermal, hydro, nuclear, and renewables. However, there is a supply-demand gap of 8 to 10%, increasing to 18 to 20% during peak demand. This has been accentuated by centralization of power generation while vast areas of the rural segment are not connected to the grid for reliable quality power.

Scope of the Indian renewable energy market

There is enormous potential for renewable energy in India. India is blessed with abundant sunshine; almost the entire country receives about 300 days of sunshine. Solar energy is about 20 MW per km^2. Available wind energy is about 45.000 MW in established, identified sites. Small hydro is about 10.000 MW. Similarly, we have huge potential in the areas of ocean thermal, sea-wave power, tidal power, bioenergy, draught animal power, energy from municipal solid waste, biogas plants, and wood fuel.

The economics of renewable energy in India are very interesting. Today, in India, the cost of generation using small hydro, wind, biomass, or biogas can compete with the cost of generation using fossil fuels. There is a very well-established policy framework and a favorable policy environment exists in India for development of renewable energy. In the last 10 years, renewable energy technologies in India have been promoted through R&D, demonstration projects, dissemination projects, and supported by government subsidies and other fiscal incentives, including:

- from the central government, the total income tax holiday for renewable energy power generation.
- accelerated depreciation.
- concessions on customs duty or no duty at all for some projects.
- capital subsidy at the national and state level.
- generation subsidies from the central government.

At the state government level, a very well-regulated framework exists where for renewable energy projects there is an energy buy-back facility available, power wheeling is permitted, power banking is permitted, and third-party sales are permitted. There are sales tax concessions, electricity tax exemption, and there is a capital subsidy on the total cost of project.

The framework for renewable energy projects is in place in India. There is a coordinating agency at the national level, and at the state capital level. As stated, power wheeling is permitted, power banking is permitted, and third-party sales are permitted. Essentially what this means is that if you set up a renewable energy project in India, you can sell it to any other purchaser, not necessarily to the state utility. Similarly, if you want to buy back from the state utilities, this is permitted.

There is an annual escalation allowed in the purchase price by the state utility. There is a small percentage charge for water availability for small hydro projects, and there is a capital subsidy provided at the state level.

The national energy plan includes specific emphasis on renewable energy development, with a main motto of environmental benignity, and meeting decentralised energy needs. The government is also in the process of formulating and enacting comprehensive renewable energy policy and legislation, which will dovetail the application and use of renewable energy with conventional energy in all applications.

India has these cumulative achievements in various sectors of renewable energy.

- Wind power: 1080 MW, the fifth largest in the world.
- Small hydro: 210 MW.
- Biomass power: 222 MW.

In addition, power is generated from municipal waste to energy production, solar water heaters, solar cookers, and biogas plants.

Obstacles in the Indian renewable energy market

As in most developing countries, the main bottlenecks for further large-scale development of renewable energy in India are

- distortions in the energy market
- east availability of conventional energy with established network arrangements
- stiff competition from subsidized conventional energy
- universal applicability of conventional energy
- lack of mega-production facilities
- high capital investment
- marginal commercial viability

Like in other countries, the barriers are:

- lack of adequate marketing mechanisms
- small number of players in the industrial segment
- while we have made considerable progress in awareness, lack of awareness is still a barrier
- lack of adequate capital at affordable cost
- limited access to financial resources and high cost of finance
- lack of micro and retail financing

The market for renewable energy by grid power is well appreciated and well established. If you set up any kind of renewable energy project in which you want to support the grid, there is a very well established regulated framework. For the off-grid applications like solar power, there are four distinct market segments.

- The government market, or selling directly to the government.
- The government-driven market, where the government subsidizes the market, then sells the products in rural areas.
- The cash market, for off-the-shelf purchases.
- Loan market, where the end user can pay over a period of 10 to 15 years.

The consumer market

There is a huge consumer market for good renewable energy devices in India. A recent study, conducted by a prestigious national institution, found the following:

- The rural market for solar devices is large, and growing fast.
- People are graduating from lower to higher income groups
- There has been a surge in the purchase of consumer products.
- The system of hire-purchase and loans for purchase is on the rise.

The size of the Indian market is roughly 1 million households which are rich, and can afford any consumer deliverables, 30 million households in the next strata of consumer class, then 50 million. These opportunities can be tackled with innovative marketing models and reliable, user-friendly products with service facilities.

Manufacturing of renewable energy devices

The annual turnover in the renewable energy industry in India has reached a level of roughly \$600 million US. The government of India plays a catalytic role in establishing the manufacturing facilities for renewable energy. Investment in this sector is attractive and hassle-free. Renewable energy has been awarded "Priority Sector" status by the Bank of India.

Wind

There are about 15 companies manufacturing different models of wind turbines, with capacities from 225 kW to 750 kW. The total domestic capacity is 500 MW. The government of India estimates that the capacity can be expanded up to 750 MW. There is a very good testing and certification facility established in India now.

India also exports wind turbines. This business is worth roughly $10 million each year.

PV Solar

There are a large number of firms manufacturing solar cells, modules, and systems. There are nine cell manufacturers, and a 24 MW installed capacity. There are 23 module manufacturers, with a capacity of 32 MW. There are 45 systems integrators, mostly in the small-scale sector. The production and consumption in the financial year ending 31 March 2000 was 9.5 MW of solar cells, 11 MW of solar modules, and exports between 6 and 7 MW of cells and modules. Total PV deployment has grown to slightly over 50 MW today.

Over thirty different types of applications have been developed. On the rural side, they include

- lighting
- water pumping
- water purification
- medical refrigeration
- telecommunications

On the industrial side, they include

- offshore oil platforms
- railway signals
- cathodic production
- battery charging

The solar PV utilization program is implemented through the state-level departments, solar shops, and manufacturers associations. Under one particular scheme, subsidies are provided on lanterns, home lighting systems, street lights, and power plants.

Only 86% of villages in India are electrified. 14% of the villages, which number roughly 80.000, have not yet been electrified. What is most significant is that of those electrified, only 31% of the rural homes are connected to the grid. There is a vast demand for decentralized PV solar home systems.

There are a large number of dispersed villages and hamlets in remote hilly and forest regions, islands, and desert areas. There is low power demand in such villages, and it is very difficult to connect these villages to a conventional grid. The government of India has recently started a program in which they are dropping grid electrification for 30.000 of these 80.000 homes, and choosing solar PV for electrification.

Solar PV is making inroads in all aspects of rural life. We have seen many common uses in rural India, such as small rural shops that use solar power to illuminate their business at night, bullock carts carrying produce which use solar lanterns to light their way, doctors operating with the help of solar lanterns, and solar-powered pumps helping farmers provide water for drip irrigation.

We have very well established test centers for the testing of solar cells, modules, and other components of PV systems. We have a solar energy center with the government of India where the testing of all types of PV and thermal devices is offered.

The grid connection of PV power is focused on two initial applications. The first is voltage support in rural grids. The other is peak demand sharing and demand-side management in rooftop systems in urban areas. Seventeen projects of 1165 kW capacity have been commissioned. Eight projects of 500 kW capacity are in progress now.

There is a World-Bank assisted PV development program of $42 million US. The fiscal and promotional incentives for solar photovoltaics are

- concessional or nil import duty.
- 100% auxiliary deposition in the first year.

- no excise duty or sales tax.
- soft loans for manufacturers of silicone and solar cells.

India imports about 80% of its requirements for silicone wafers. The government of India is willing to provide soft funding for a silicone wafer manufacturing facility in India now.

From the years 1997 to 2002, the government has a target of 18 MW.

Other renewable energies

There is a highly developed solar water heating industry in India, consisting of 43 manufacturers which are established and certified by the Indian Bureau of Standards.

In the biomass and sugar mill cogeneration, and small hydro sectors, there are also very good manufacturers. In these sectors, India is now exporting boilers and turbines to neighboring countries.

The potential for biomass energy generation is about 16.000 MW from available biomass, and about 3.500 MW from biogas.

There are about 4.000 sited identified as appropriate for small hydro power, and ready for commercialization. The total capacity is about 10.000 MW.

Another area growing rapidly in India is energy recovery from different wastes, both in the urban and industrial sectors. Since last year there has been rapid growth in this area, showing exponential growth for waste-based RE projects.

Foreign investment

Foreign investment in the solar sector is subject to automatic approval with foreign equity of up to 74%. For other renewable energy projects, foreign equity of up to 100% is allowed. The total foreign investment approved is about $66 million in the manufacturing sector.

A recently conducted study has projected that with medium incentives and support by the government and other agencies, the installed renewable energy capacity in India can increase to around 16.000 MW by 2015. This would place renewable energies at about 8% of the total generating capacity. The major hindrance is that an investment of approximately $37 billion US is required. This provides an attractive opportunity for multilateral agencies, bilateral agencies, financial institutions, and overseas investors to participate in the renewable energy movement in India.

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Renewable Energy Strategies in the Mekong Region

Tien-Ake Tiyapongpattana

Introduction

"In promotion of Renewable Energy, great success is rarely achieve alone. The regional network blend individual strengths to gain collective achievement."

Overview of the Mekong area

The Mekong River winds through several countries namely (South) China, Myanmar, Laos, Thailand, Cambodia and Vietnam. It is clear that the entire region will need more and more energy and today's production cannot provide it.

Some countries have developed resources better as has the Yunnan province of China or Thailand, but other such as Cambodia and Lao have little energy infrastructure and limited electricity network.

For instance Cambodia imports all its petroleum products: 35% is used for electricity and 25% is used for water pumping. On the offshore resources, will be exploited only in a rather far future. Though a few big towns have centralized electricity, but it is not enough; there are more than 25,000 electric generator running on oil in Phnom Penh.

- Wood is the first energy source in Cambodia (more than 8 million tons per year) it is much used in the form of charcoal, even in towns (1 m^3 for a 5 person-family). The rising demand creates a very harmful deforestation and atmospheric pollution.
- 550 biogas devices were installed in 1995, it is not enough to make a difference in the energy balance.
- PV and wind generators are in very few numbers and for very low power, mostly only for demonstration.
- Hydro electricity for supplying big towns would be enough if exploited, but they have mostly been damaged or limited for further investment due to environmental impacts on biodiversity.

Definitely, decentralized energy by the large development and commercialization of renewable energy would be a good solution to help the country to go through a hard transition period and to develop faster, reducing the too rapid emigration of people to towns where infrastructure are not ready to welcome them.

Despite each government and concerned responsible agencies in each countries efforts to satisfy the growing energy demands by cooperation with private sector and international development agencies, the objective remaining far from reality. The major barriers are political framework, the economic situation, and financials problems, availability and social acceptance of technology.

Actors and Strategies on Renewable Energy in the Region

Since 1994 and 1995, the scientists and people who work together on renewable energy in the region have tried to come up with the ideas of what they could do to help each other.

The Council on Renewable Energy in Mekong Region (CORE) was established in 1996 as a kind of self-help process to promote applications of Renewable Energy Technology (RET) in the region. It is an informal network of persons and organizations working together

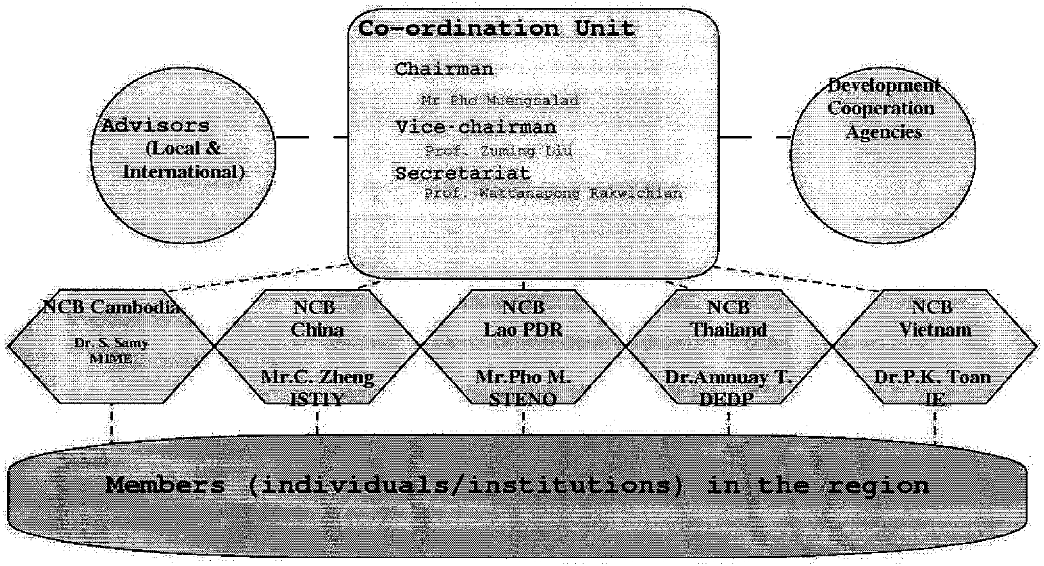

Figure 1: CORE Organizational Structure (1998-2000)

to contribute their informal capacities without representing their government. It is a non-governmental and non-profit organization administered under the Statutes of the Council, which is adopted by the Advisory Committee (see organizational structure on this page).

CORE members in the region believe that working together avoids reinventing the wheel. Moreover, integration of differences could make more progress towards higher achievements. CORE activities focus on four main aspects:

1. Institutional Development
   - To enhance coordination among key partners at both regional and national levels,
   - To strengthen capacity of the local experts.
2. Information and Awareness
   - To exchange knowledge and experiences among institutions,
   - To raise awareness of the policy decision-makers and local community regarding to RET applications.
3. Technology Development
   - To support research and development including transfer of RET.
4. Promotion of Commercialization
   - To facilitate commercialization of RET in the region.

Since it was established, the regional networking is quite active, continuously motivated, and gradually growth. Several intermediate results achieved by co-efforts at national, regional and international levels, for instance.

1. Exchange events are regularly organized by rotation of host country within the region:
   - Regional seminar on "Financing and Commercialization of Solar energy in Southeast Asia", in Kunming, Yunnan Province, China (1996),
   - International Seminar on "Sustainable Energy in the Mekong Region', in Phitsanulok, Thailand (1996),
   - Regional meeting on "organizational Development of CORE", Luangprabang, Lao (1997),

- Regional Seminar on Institutional Cooperation for Solar Energy Promotion in Mekong Reparian Countries" in Hanoi, Vietnam (1998),
- International Seminar on reducing Barriers for the Commercialization of Renewable Energy in the Mekong Region" in Bangkok, Thailand (2000).

2. Human resources development to qualify local human resources with international and regional experts:

   - Established International M.Sc. Program on Renewable Energy at Naresuan University,
   - Organize short training courses on both management and technical matters for local and regional experts.

3. Research, development and transfer of technology to develop and/or adapt RET to the region:

   - Intra-regional co-operations (South-South) e.g. PV encapsulation,
   - Inter-regional cooperation (North-South) e.g. bilateral cooperation programs.

This is not a success story but an on-going process of how local and regional agencies working together towards common goals. Problems and barriers are still remaining and challenging all concerned parties.

In order to enhance the regional networking process, CORE members are pleased to welcome all interested individuals or institutions worldwide to share information, experiences and resources to promote applications of renewable energy in the Mekong region.

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Power Generation Plan of the State of Ceará/Brazil - Strategy for Renewable Energies

Adão Linhares Muniz

Abstract

This work presents the basic political guidelines of the Government of the State of Ceará to meet the increasing power demand. This policy aims to make the State of Ceará self-sufficient in power generation, in order to provide the infrastructure necessary for the economic development of the State, and universalize power supply to the population as a whole.

This work discusses the initial conditions of the state's power dependency vis-à-vis the national electric power system and the current context of the Brazilian power sector, which is currently undergoing a restructuring and liberalization process. Further points of discussion are

- (a) the state's power matrix and the evolution of indicators derived from the economic development policy carried out by the State Government;
- (b) the need of power self-sufficiency through the thermal generation by natural gas;
- (c) the assessment of renewable power sources - solar and wind power, small hydroelectric plants and biomass;
- (d) the potential of large-scale power generation with renewable sources; and
- (e) the decentralized generation using renewable sources - solar and wind power, small hydroelectric plants and biomass.

Introduction

The current economic development model is marked by ever increasing consumption of non-renewable energy sources and environmental degradation. There is little doubt about an urgent need to restructure our economies in a way that leads to less resource consumption and maintains evironmental goods for future generations. Against this background, the state government of Ceará has developed a plan for a sustainable use of renewable energy sources with the ultimate goal of enhancing the quality of life for today's and for future generations.

Energy Policy for the State of Ceará

Ceará as part of the national power grid Ceará is located in north-eastern Brazil, with a land area of roughly 150,000 km^2 and a coastline of 573 km length. The size of the population is about 7,000,000, 70% of which are living in urban and 30% in rural areas. Ceará's population represents 15.2% of the population of the North-East and 4.3% of the national population.

In terms of power supply, Ceará largely depends on electricity from the large hydropower plants of the Northern regions and along the São Francisco river which is carried through transmission lines over long distances to the North East. So far, this system adequately served the electricity needs of the region. However, the rapidly growing electricity demand-caused by an increase in population and economic activity-together with the unpredictable effects of liberalized energy markets have led the state government of Ceará to conceive a new energy policy with a focus on security of supply.

Currently, the potential for additional hydro power generation in the North East is very limited. A fruther increase in demand will probably have to be met by transmission from other generating regions, with the effect of higher prices and an increased dependency on those regions. But there is also an environmental dimension of the problem pushing us to rethink our energy mix, namely the large share of firewood in primary energy demand.

Firewood is widely used to produce pottery and bread, a.o., contributing to the problem of inland desertification.

To reduce dependency on both, electricity imports from distant regions and unsustainable use of firewood, the state government-in accordance with the federal policy-set the goal of increasing the share of natural gas to 12% within 10 years.

Given the fact, that energy demand in Ceará is predicted to increase 5% p.a. for the next 20 years, it is clear that including natural gas into the energy mix is important but not sufficienct to mitigate the problems of fading energy security and environmental degradation. In addition, a local potential for energy production, based on renewable sources like solar, wind and biomass has to be developed.

Renewable Energy Sources in Ceará

The geographic location of Ceará at the north-eastern Atlantic coastline of Brazil and close to the equator entails excellent conditions for electricity generation from solar and wind energy. Preliminary studies of COELCE (Companhia Energética do Ceará), the local utility, show that using the wind energy along 20% of Ceará's 573km-coastline could yield 10,400 GW·h of electricity per year.

The conditions for electricity generation from solar energy are also very favourable. 7.3 hours of sunshine yield 5.6 kW·h/m2 of energy per day (both yearly average)-one of the highest numbers world wide. These conditions prevail on a land area of 43000 km2, with typically low population density and low prices for land property.

The potential for energy from biomass is largely based on crop residues from the cashew and coconut industry. The cashewnut industry alone produces more than 10,000 tonnes of residues each year.

The potential of other renewable energy technologies in Ceará is limited but significant (see table 1).

Plan for the use of renewable energy sources in the state of Ceará

The state government promotes the increased use of renewable energy sources through tax credits and additional support (infrastructure, permissions etc.) for companies active in the development, production and dissemination of renewable energy technologies. Furthermore, Ceará actively participates in negotiations on the federal level under auspices of the ministry of energy aimed at the development of guidelines for a sustainable use of renewable energy sources. Reaching out beyond national borders, the state government of Ceará is currently engaged in talks with the state of North-Rhine Westphalia, with the goal to reach a mutual agreement on industrial investment, trade and technology cooperation in the field of renewable energy. Stimulating partnerships between companies of the renewable energy sector of both states is an important goal of this initiative.

Wind Energy

Ceará is a pioneering region for wind energy in Brazil. So far, three commercial wind farms contribute to the electricity supply of the state. They are located at Mucuripe (1,2 MW, Coelce/Chesf 1997), Taiba (5 MW, Wobben/Enercon 1999) and Prainha (10 MW, Wobben/Enercon,1999). Two additional large farms-30 MW each, to be installed at Paracur and Camocim-will be put out for tender in the near future.

The state government has set a target of 1000 MW of wind energy capacity to be installed within 10 years. For that purpose, a cartographical analysis of wind conditions is underway and will be published this year. An in-depth investigation of potential technical problems caused by feeding electricity from wind turbines into the grid in large quantities was recently commissioned by the Secretariat for Infrastructure (SEINFRA) together with CHESF, a utility based at São Francisco.

Solar Energy

The state of Ceará participates in a programm of the federal ministry for energy, which promotes the use of photovoltaic systems for water pumping, lighting, household electricity, schools and health stations in rural areas off the grid (Programa de Desenvolvimento Energético para Estados e Municípios - PRODEEM / Programm zur Energieentwicklung für Länder und Gemeinden).

With the help of the state government, the

Source	Generating capacity (GWh/a)	Compared to current energy demand (in%)
Wind	10,400	192.3
Biomass	4,222	78.2
Small hydro	181	3.4
Total	14,803	273.9

Table 1: Potential of energy production from renewable sources in the state of Cear/Brazil (without solar energy)

Federal Ministry of Energy, the bank BNB (Banco do Nordeste), the Federal University of Ceará and the Institute for Sustainable Development and Renewable Energies (IDER), the following number of systems has been installed so far: 155 systems for water pumping, 623 for household-electricity, 27 for schools, 71 for street lighting, 14 for health-stations, 132 for public telephones and 23 for food production. The target of PRODEEM for the years 2000 and 2001 are to install 527 systems for water pumping, 474 for schools, 32 for street lighting and 1000 for desalination,

Another federal activity in which Ceará actively participates is the programme on rural electrification "Luz no Campo" (Light in the Country). The Ministry of Energy set the goal to serve 95% of Ceará's population with grid electricity until 2002. The remaining 5% of the population in very remote areas (20,000 households) is planned to be served with photovoltaic systems.

To assess the exact demand, a study of the state government together with the Office for the Development of the North East (SUDENE) is under way and planned to be finished by late 2000. The implementation of the programme could be an element of the above mentioned cooperation agreement between the states of Ceará and North-Rhine Westphalia. Within the same framework, Ceará intends to explore the potential for solar thermal systems (using concentrating solar collectors). State support will be available for feasibility-studies in this field of technology.

Biomass

The states of Ceará and North-Rhine Westphalia collaborate in the development of a programme for the use of biomasse in Ceará. The initiative is based on partnerships between the private sectors of both states. The company DENARO (NRW) is coordinating the effort, which aims at the use of organic residues from industry, agriculture, households of the urban areas of Fortaleza and Sobral for the purpose of electricity production.

In the first phase of this project, waste of the city of Sobral (36,000 t p.a.) will be separated, metals, plastics and glass will be recycled and the organic fractions used to produce biogas, electricity and organic fertilizer. In a second phase the Fortaleza area (1,600,000 t p.a.) will be included.

> *"The best way to foresee the future is to create it." – Peter Drucker, transl.*

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Renewable Energy Strategies for Ceará/Brazil

Armando Leite Mendes de Abreu

Introduction

Good morning ladies and gentlemen. My name is Armando Abreu. I come from Brazil, where I am the general director of a non-governmental institution, whose name is IDER. We've worked for over 10 years on renewable energies in all of Brazil, particularly in the State of Ceará, as well as other governments in the north-east.

Solar energy in Ceará

There are 623 solar home systems installed in Ceará. In addition, there are solar installations at 27 schools, 14 health centers, 155 water pumping systems, among others. We don't have the scale of China or India, because we are a small state with 7 million people. Most of these projects came from state and federal programs, through the Ministry of Mines and Energy, the State of Ceará, the BNB, local utility COELCE, and IDER.

One of the most important projects for the future is a federal and state project named "Luz no Campo". The goal of this project is to electrify 100% of the rural communities, and will run until the end of 2003. For a long time, the federal and state governments have understood that it is impossible to achieve 100% electrification of rural areas using conventional energy. Four years ago, they began to look at renewable energies as the ideal complement to conventional energy. We are preparing to implement this project over the next four to five years.

It's important to talk about how we'll actually implement this project. All the speakers so far have spoken about sustainability, maintenance, and operation of a project, but once in the field it's often a completely different operation. Things are difficult to implement. We don't have a miracle formula, every case and community are unique.

Four years ago, we were implementing small sustainable projects in Ceará. They have operated all this time in a sustainable fashion, using only local maintenance and technical assistance. We also implemented revolving funds over this time; people have remained willing to pay throughout. Based on the experience from these projects, we are now trying to implement the "Luz no Campo" program.

Field Methodology

A small summary of the methodology we're using is important. We're not concerned with the technology, we know it works. Sometimes there are issues with getting a financial institution to finance the projects. However, the most important problem is how to actually do it in the field; not a test of equipment or pilot projects, but real projects. This methodology is not being used only by the state government of Ceará, but also for other states in the north-east. It is:

1. Identify the municipalities and communities interested in the project.
2. List and select communities.
3. Make a local energy plan.
4. Completely identify all families.
5. Develop an energy project for each locality.

Figure 1: Construction in Ceará.

Figure 2: Rural PV energy.

The point about completely identifying all families is particularly important. Most poor families probably already spend money on traditional energy – kerosene, fuel, batteries, and such. For example, in the Ceará area, most families spend between $7.50 US and $15 US on such fuel. You can inform and educate these people to move that money to new, clean energies. Several projects in Ceará are currently working on this important principle.

A vital component of the method is to train local human resources for installation and maintenance. In practice, local technicians will do most of the installation. In almost all rural communities, there will be at least one fairly talented, curious person who typically takes care of local radios and TVs.

There are also often local jobs that involve selling batteries, maintenance of electronics and electrical equipment, and so on. If you can provide good training, these are the people that can be used as local human resources to support the project.

It's also vital to tell people how to use renewable energy. They must know exactly what they are buying; it's not conventional energy. We must explain to them the limits the systems have. Some projects have not met with success because the people haven't been informed.

A revolving fund must be created. This revolving fund is sometimes the secret of success for the project. Through this revolving fund, you can pay for the local technicians, the equipment (in the case of commercial operations), or create a fund for future battery replacement. It's possible to maintain this on the normal amounts spent on conventional energy – between $7.50 and $15 US.

Solar projects can't be installed, and then forgotten. You must supervise and involve the locals, at least during the first six to twelve months. We feel that solar projects aren't only a purely commercial business – we must include work for the customers. If you don't, you won't sell solar PV.

In many countries, including Brazil, there have been many unsuccessful projects because the project was merely installed, like a donation. We don't believe in pure donations. If you don't involve the communities in the decisions, they will not feel any attachment to the project. They will think it's something given to them by the government.

Criteria for selection of communities

We use four main criteria:

- Distance from the electric grid. Normally, we consider communities over five kilometers away, but this is only a guideline – communities are evaluated case by case. For example, in Ceará and in the northeast, most of the communities are very dispersed. We don't have streets lined with houses. Normally, the residences are far from each other. In this case, we may have a community near the grid, but it's not feasible to electrify the community with conventional energy.
- Population.[paragraph split titles here] Normally in Ceará we only consider communities of at least thirty families.
- Community organization. The community may have one leader, or a local association. It's important to help maintain this, as the leaders of the community are the points of contact in the community in the future.
- Sustainability of the project. The following points are key in making an electrification project sustainable.

1. Electrification must be part of an integrated development project; it must not be an isolated project.
2. The local population must participate in the project.
3. The project must use proven technologies. Sometimes, we've tried to use the community as a test-bed for experiments. This is a mistake. The failure of one project can destroy a larger strategy. Using proven technology is particularly important for maintenance in rural areas, where spare parts can be in short supply. If the spare parts have to be shipped two thousand kilometers, it makes the situation almost impossible.
4. Revolving fund.
5. Qualification of local human resources.

Our goal of electrifying 20,000 households will be achieved using this methodology.

Biomass projects.

We are developing a new waste treatment concept for the state of Ceará. It's being developed with the partnership of the state government of Ceará, the government of North-Rhine Westphalia, Denaro Energy, and Braselco. This project will include the two main towns of Ceará: Fortaleza (2,5 million persons) and Sobral (250.000 persons).

We think that by the end of this year, we will identify three or four projects and start with them. They will be very important because until one or two years ago, biomass was not a part of the energy matters of Ceará. Now, it will be.

Thank you.

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Renewable Energy Strategies in Argentina

Erico Spinadel

Introduction

I'd like to give you some background information on the current conditions in Argentina. Next, I'll tell you about our wind energy association, followed by a description of the Argentinian energy market, and our strategies for using renewable energy in the near future.

Some years ago, I visited different countries in Europe with my wife and children. We spent a night in a small hotel in Tyrol, in Austria. I told the hotel owner we were from Argentina. The next day, he said he'd found Argentina on the atlas: "it lies far south between Italy and Switzerland." I imagine from Tyrol, this is indeed the right direction, but just a bit further.

Far away as we are, I believe that in a globalized world, the most important reserve of wind energy is held in Patagonia, and the most important reserve of clean pure water is in the Patagonian Andes. Perhaps this will make Argentina an important country in the following years.

A brief economic history of modern Argentina

There have been many difficulties in Argentina. In 1976, the Argentine national debt was some ten thousand million dollars. Then came a military government, and after eight years in which there was almost a war with Chile, and a lost war with the United Kingdom, our debt climbed to some twenty-five thousand million dollars. Then we returned to democracy, and after sixteen years of democracy, selling whatever we could sell – railroads, oil fields, and services formerly owned by the state, the national debt reached some one hundred twenty thousand million dollars. Our government is fully engaged in trying to find ways to pay the interest of that debt. As such, our government is not in a position to study matters concerned with the use of renewable energies. If a civil servant tries to start such studies, they will be violating the interests of the most powerful lobbies we have; the oil lobby, the nuclear lobby, and the hydroelectric generation lobby. That is why, in Argentina, the only possibility for using renewable energies is if it comes from the efforts of non-governmental organizations. Our Argentine Wind Energy Association is one of those.

Role of the Argentine Wind Energy Association

The Argentine Wind Energy Association is a non-governmental, non-profit organization. The board is composed of professors from different universities in our country. Most of them are professors eremitus, and consulting professors, as I am. As in Argentina teaching at a university is another non-profit activity, all of us have good experience with renewable energy, which we promote through our Wind Energy Association.

We try to be realistic in our activities. Our goal is to contribute to what we call sustainable human development. Some of the speakers today have pointed out that we will need education for our people. Argentina has some thirty-five million inhabitants, and, sadly, we don't know what to do with some twenty million of them, due to their lack of education, poverty, and remote location. We must try to create some conditions for them that help them to survive.

In this idea of sustainable human development, the proper use of energy is quite important. We are trying to educate those from the government to the poorest sectors of our society, in what to do to create these conditions.

Renewable energy options in Argentina

As I said, we try to be realistic. As all of you know, not all that is green is good, and not all that is cheap is bad. In all our activities concerning energy, we should try to obtain this balance between economy and ecology; otherwise, there is no hope of developing anything.

The different alternatives considered in Argentina are biogas, solar thermal, solar PV, microturbines, and most of all, wind energy.

- Biogas is widely used in remote communities. At higher levels, the prevailing feeling within the Argentine government is to bury the wastes, and not to convert it into biogas in any industrial plants. Natural gas is very cheap in Argentina, and we have large reserves.
- Solar thermal is very seldom employed; certainly not in remote communities.
- Solar photovoltaic offers no chance of technology transfer to small Argentinian industries. It is used in some communication work, shipping, and buoy systems.
- Microturbines are used in several remote locations in the Andes.
- The only remaining possibility is wind energy.

For wind energy, we must consider that the Argentine electricity market was privatized in 1992. It is strictly divided in into generators, carriers, and distributors. No generator is allowed to sell to consumers, except in the case of very small co-operatives which had been acting in the market before 1992.

Electricity generation in Argentina

In the most remote communities, everyone knows the importance of electricity in modern life. As such, all use of renewables in Argentina is intended for the production of electricity.

Since starting with combined cycle gas/steam power generation, everything has changed in the power market. Like in Brazil, where there are many power plant projects under way and all are combined cycle, nobody talks about separate gas or steam power plants in Argentina any more.

At the end of 1998, there was a total installed market capacity of roughly 22 GW. The highest peak of generation took place in 1999, when over 70.000 GW·h were generated during the whole year; this peak represented the use of slightly less than 13 GW of the installed capacity. The important point is that this historical peak demand was less than two-thirds of the total generating capacity.

The costs of combined cycle generation are below 2 cents per kW·h. If you add to the capacity of thermal plants those of nuclear and hydro, you reach a total of 19.5 GW, to supply a peak demand of less than 13 GW. At this point, the cost of generation by this mix is about 2,7 cents per kW·h.

Wind Generation

In Patagonia, we have very strong winds with mean values of 10 m/s or higher. This area is some two thousand miles away from the Argentine energy net. Electricity generation by wind farms in this part of the country is quite useless, because we have no way of transferring the electric power to the north.

Another promising site is on the Atlantic coast of the Buenos Aires province, where the mean wind speeds are roughly 7.2 to 7.3 m/s. However, due to the federal law of 1992 mentioned earlier, the only companies which may sell electricity are those which were awarded licenses at that time (1992), which are good for 20 years; until the year 2012. Under the same regulations, they are able to buy electricity at the spot market for less than 3 cents/kW·h. In that region, if everything runs smoothly, we could generate wind-electricity at a cost of roughly 6 cents/kW·h.

We proposed a law to the Menem administration, two years ago, which was approved after much discussion in congress. This law gives a wind generator a benefit of 1 cent/kW·h. Any more than this would conflict with the interests of the gas and petroleum lobbies, which are placed in a very opportune position for the 20 years following 1992. To modify this position would be legally discontinuous; we would be unable to obtain new investment in Argentina if we were inconsistent with our legal arrangements.

Generating at a cost of 6 cents/kW·h, with a benefit of 1 cent/kW·h still results in a loss when selling at 3 cents/kW·h. Even if you add another cent/kW·h, as promised by the Buenos Aires province government, you will have a generation cost of US$0.04. If you can find a way to generate at this cost and still make money, you certainly will very quickly become a millionaire, in Argentina or in any other countriy.

Gas consumption has been dramatically increasing in recent years, and it's still climbing. Compressed Natural Gas gives an opportunity for a Daimler-Chrysler fuel cell powered car project; these fuel cells could also be used in a near future for domestic, decentralized electricity.

Market strategies

At the kW level, our proposal is based on two points:

- wind-powered battery chargers, running in a stand-alone fashion, or complementing existing diesel generators.
- autonomous wind electricity electrolizer, which generates H_2 for storage, which can be fed to a local fuel cell.

The second method was developed with a German university, and is called the "Hacienda Project". It is intended to help the rural agricultural regions of Argentina. It was presented in the Argentinian Farm Fair three months ago. We hope to have an installed prototype in time for the next farm fair, in March 2001.

At the MW market level, our main problem is that to be profitable, we have to generate at less than 3 cents/kW·h. Therefore, there is an installed base of only 13 MW of wind electricity generation, on a market which has an installed capacity of 22.000 MW.

In the Chubut province, in Patagonia, electricity is produced locally and sold to the local net. This is done by co-operatives which are allowed to sell directly to customers, bypassing the monopolistic privileges of companies in the Buenos Aires Province. In this province of Buenos Aires, there are only some small co-operatives which existed before 1992. There are no new possibilities for wind farms.

The equipment for existing wind farms is provided by Danish companies. There was some early use of German equipment, with poor results. The first wind park was in Rio Mayo; a small park with M.A.N. mills. It worked for three years, then changed owners and is now out of order. The next adventure was with Ventis, who installed a one MW farm south of Chubut, in the Santa Cruz province, where there are very good wind conditions. You know what happened to Ventis; you can imagine what happened to the wind park. German companies are not presently active in the wind field in Argentina. It will not be easy for Germany to come back to the market, either. The Wind Association will do all we can to help, but the Danish companies are very aggressive. Only Enercon, with its brasilian plant of Wobben do Brasil, is starting with a small project, intended to reemplace the former Ventis Farm in Pico Truncado, Santa Cruz Province.

The future in Argentina

The existing arrangement, and the difficulties of working profitably with wind in Argentina cannot easily be modified; we would have serious international troubles if we changed the monopolistic facilities we've given to the companies. The only hope we have is that we can really introduce the concept of the "Green Price", as is currently being done in the United States. The general idea is that if, for example, you try to install a wind farm in the province of Buenos Aires, and the people there are willing to pay the distributor the price that must be charged, then it would be possible.

I think the market at the MW level should be exploited by the German manufacturers, as the future of wind energy use in Argentina lies on the GW level. We hope that by the early 2020s, we will be able to export wind energy to the Japanese market in the form of liquid hydrogen. We could do so in better conditions than Canada, with the Hydro Quebec project, or the North Africa, with the HYSOLAR project. We have performed studies which show that we could readily enter the Japanese and Far Eastern market. An installation in the southern Chubut and Santa Cruz provinces, in an area no bigger than 400 km^2, would be in a position to export the equivalent of 46.000 barrels of oil daily to Japan. This project would be competitive when oil reaches a price of $40 US per barrel. I don't believe we are far from this value.

My message for the German industry is to aim for the MW level, change their bad image in Argentina, then switch over to the GW level, and be in a position for very large earnings in the near future.

Thank you.

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Renewable Energy Strategies in South Africa

Dieter Holm

Introduction

The South African energy market is still dominated by fossil fuels and their interests. There is one state owned monopoly electrical utility. In spite of record breaking grid extension, the majority has no access to grid power. To recover only the grid extension costs 350-350 kW·h per month must be used and paid for per household. Present consumption (with partial payment) is a mere 83kW·h/month. The motivation for a market transformation is given. A realistic 20% RE target for 2020 agrees with the Shell scenario. Four crucial market transformation indicators are presented, as well as a selection of current RE projects; there is good reason for optimism.

I'm very pleased to see a number of my colleagues from the continent. I think I have good news for you, from a continent that does not always have good news for the world. I also note with appreciation the presence of the first secretary of the embassy, Mr. Pierre Jordaan.

The South African energy market

First of all, the existing South African system is based on fossil fuels. Most of it is coal, which is very shallow; much of it is in open-cast mines. The power stations sit right on the mines, which is quite convenient and amenable to a high degree of mechanisation with low job opportunities. Coal is used for direct fires, for electricity, and for synfuels by a process which was originally developed in Germany during World War Two. Oil is used mainly for transport.

At the moment, we have a single monopoly state-owned utility, which is amongst the largest five in the world. It is based on large-scale electrification, and of cheap energy, which excludes externalities - no tax is paid, and the state backs up international funding.

A major problem is that it does not reach the rural areas. This creates social problems, and causes migration from the rural areas into urban areas. Current connection to the grid is being done at a record pace.

Each new house added to the grid adds to the loss. To only pay for the urban grid extension, we need between 350 to 380 kW·h sold per month. The present rate of use is 83 kW·h per month. You can see it is not anywhere near the optimum mark. It is also used mainly for recreation and lighting, which is not really a very productive use of energy.

The need for a market transformation

We need a market transformation towards renewables, because we produce about 60% of the continent's electricity, and it is all done in a highly polluting fashion. We also desperately need the work opportunities created in comparatively much greater numbers by renewable energies. The market transformation has to be rapid, and it has to be sustained. Many ad-hoc efforts have been made at transformation, and as soon as it happens, people tend to reverse, and that is a misinvestment. The large scale grid electrification of low income houses was motivated by the expectation that inefficient domestic coal burning and its resultant air pollution would be reduced drastically. Surprisingly, a recent study shows an increase in coal consumption.

The driving factors in South Africa are slightly different from in Europe and America. The first priority you will see is "job creation", not "the environment".

The least-cost option, in terms of life-cycle cost, is rural energy. Not rural electricity — RURAL ENERGY.

On the issue of productivity and competitiveness, we have woken up to the fact that cheap energy does not necessarily mean competitiveness. In fact, if you look at analyses, the opposite is true. We need private sector initiatives. We have a history of very centralised government, but we need private sector involvement. Another important consideration is risk management in the provision of power and energy. As electricity gets cheaper and cheaper, mainly by government pressure, the quality of the service deteriorates, and people are left alone without power. Of course, this is very bad if you have a production that is dependent on a secure source of electricity. It is even worse if you need reasonably constant voltages. At present in Nairobi they have electricity for about 6 hours per day.

Any market reforms will also be run on government intervention and the fear of environmental sanctions. It is not so much driven by popular demand at the moment, demanding environmental issues, but rather by the fear that if we are producing exports made with dirty energy, we may not enter the international market. This is what sanctions can do. Finally, as a last priority, come concerns of environment.

Another thing driving this is availability of resources. Southern Africa receives 59% - almost two thirds - of the total highest intensity sunshine in winter. If you add up Egypt and Sudan, together with Southern Africa, you see how much is left for the world to share. That is five percent for the rest of the world. The funny thing in this case is that the resource that is most abundant, is also the least applied.

Targets for market transformation

We decided to aim for 20% renewable energy by 2020, which agrees with the Shell scenario.

Primary energy supply in South Africa is dominated by coal, next is crude, and the rest is diminishing. In terms of market penetration you can see a definite dive in the coal percentage, and the others rising, and I would like to stress: it is commercial energies again.

Looking at the target renewable energy contribution to the net estimated fuel, you can see that commercial renewables will overtake, for instance, coal somewhere between 2010 and 2015.

A major growth, sticking out from the crowd of renewables is solar water heating. At the moment it is less than 0,1 m^2 per person. Given the sunshine levels in the country, it is really frightening that people do not use it. A large percentage of domestic solar water heaters are imported. I should also mention that over 50% of the hot water used for industrial processes is less than 100 C.

Coming to the targets again, let's share a few details with you. The way we think market penetration will be measured is by the A4 potential, being composed of the product of Awareness, times Acceptance, times Access, times Affordability. It works in that sequence.

- Awareness: If you are not aware of a product, you will not be able to buy it, or you are very unlikely to buy it unless you buy things in the middle of the night.

We think education has to be done by activists, NGOs and such groups, and liaisons between them - no-one will run it on their own.

- Acceptance means desirability - how urgently and how seriously do you desire to have the product.

Government papers are in place in most instances, but there is a lack of commitment in the sense of placing resources (time, money, men) for this issue of renewables.

If people talk and write about it but they do not put their money where their mouth is, nothing much happens. There must be real government intervention, and we need it on projects and initiatives.

- Access means "can you buy it in a rural area - can you get it?" Can you get PV panels? Is it easy to buy a windmill? Is it easy to buy solar water heating panels?

- The last is Affordability, based on life-cycle cost.

Access and affordability, we believe, will be mostly driven by market forces, training, and real investment. A good analysis of investment possibilities in the Southern African development area has been produced as a Guide for Investors, made by ISES (the International Solar Energy Society) which I also represent here, and by the Development Bank of Southern Africa (DBSA).

It is available from Mr. Burkhard Holder, the executive director of the International Solar Energy Society, placed here in Freiburg. We are very honoured to have them here. He also has other material which he would like to distribute to you.

Current Projects

We have, at the moment, a market of about $7 million US. 2.5 million solar homes are expected to be built within the next 10 years. A major issue is water pumping - which is replacing windmills at a rate of 0,8 MW per year. Schools and clinics are linked through the educational and health programmes. We are using street-lights extensively for communications - telecommunications make approximately 60% of our PV projects.

Wind has excellent conditions around the coast. This diminishes towards the inland areas. A 5 MW wind turbine project is being planned at Darling. Mr. Oelsner from South Africa is present in the hall; if you wish to speak to him afterwards I am sure he would answer questions. A 200 MW upwind chimney is being projected in the Northern Cape. Mr W-W Stinnes can be contacted on that.

Hydro is small, with only 0.4 MW currently, and no large-scale projects planned.

As for passive solar design, 1,800 houses have been built in Alexandra, which is part of the All-African games village. 2,400 houses are being built in the Pretoria area, at Hartbeespoort Dam, where I am from. It is part of an integrated resource plan issue, meaning also the provision of water. Space heating reduction expected is about 40% - 50%. Guidelines have been prepared by the state's Department of Mineral and Energy Affairs. It is a Guideline, Primer, and also a Manual.

Further, a very important one that is really in the process of being born at the moment, is a renewable energy demo project on an island. It is part of the ISES "Islands in the Sun" programme. Robben Island, as you know, has received some political attention. The idea was that it would be used both as a museum and a demonstration, in that all the local power would be provided in a clean and sustainable way.

We need energy targets for housing to be set by the Authorities. A computer program has been prepared and tested for South African conditions for passive solar design. There is a sustainable development foundation doing training, both for technicians and for designers. The leading universities are active in Renewable Energies.

In conclusion, we would like so share this idea with you that Southern Africa is THE growth centre for renewable energies.

With that I thank you.

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Renewable Energy Strategies in Morocco

Mohamed Berdai

Introduction

The purpose of this paper is to present a brief overview of the power sector in Morocco, the context for renewable energy development, the application fields for renewable energy like electricity production, rural energies, and the improvement of energy efficiency. The paper conclusion will present some recommendations taking into account Morocco experience.

Morocco energy consumption

The total energy consumption is around 10 million TEP (67% oil, 23% coal). Wood fire for traditional use, particularly used in rural areas, represent 3.5 million TEP. Morocco import around 90% of it's commercial energy and have a rate of rural electrification at around 40%. The total investment over the last 5 years in the energy sector is around \$2.6 billion. Morocco priorities are :

- ensure energy supply
- provide energy at thebest price, taking into account environmental aspects, and looking for competitiveness
- develop the use of commercial energy in rural areas and use of renewable energies.

Reforms of the energy sector

During the last 5 years, the energy sectors had very deep reforms, such as

- Introduction of privatization for refineries,
- Concessions of electricity production (BOT). The legal and regulatory framework is in place, and we have already started two projects.
  1. The first one is a of 1300 MW thermal plant.
  2. The second is a 50 MW wind park.
- Open pricing for oil projects, partly to have more transparency to international markets.
- New electricity pricing to reduce peak load demand. We currently have a peak load that is 2 times higher than our low demand.
- Rural electrification.
- Development of regional network including electrical interconnection, and a gas pipeline from Algeria to Spain.

All these reforms have some impact on renewables, which are discussed below.

Morocco is interested in renewable energies

- to produce electricity thanks to diversified natural resources.

We have a 1000 MW hydro-electric plant installed, wind resource could potentially provide 2000 MW, the average solar resource is high with 5 kW·h / m^2 / day and biomass also offer opportunities regarding roughly 10 million hectares of forest.

- to provide energy for rural areas.

There is currently a lack of commercial interest from conventional energy sectors in those areas where the needs are diffuse but globally high. In these areas where the pressure on wood resources is important, renewable energy could be very helpful for lighting, cooking and heating.

- to improve energy efficiency

in looking for industry competitiveness and environmental preservation and prepare the opening of Euro- Mediterranean free market (2010)

Renewable energy in Morocco

Current electricity production projects for wind farms include

- an ongoing 50 MW project.
- a 3 MW project, in the frame of the German co-operation from the KFW.
- three parks with a total production of 200 MW under preparation.

These should be operational before 2004. By 2004, the contribution to electricity generation should be 10% from wind systems.

There are other potential sources of electricity under study right now, and we hope to achieve some concrete results soon. One possibility is a thermal solar units with combined cycle power plants using gas. Global Environmental Facility (GEF) is expected to support of roughly $50 million to implement this project. Other projects are under study right now in Morocco and concern waste energy valorization.

Rural electrification

Another important area where renewable energy could play a role is in energy for rural populations. in 1995 we had a rate of rural electrification of less than 15%. As a result of a large electrification program, it is now around 40%. The demand is very high (30.000 villages). Thousand of villages are self-electrified, typically at their own initiatives, often by diesel generator sets. We have also very dynamic private market for PV. 30.000 PV domestic systems are installed (4 MWp).

The global program for rural electrification (PERG) launched 5 years ago combines the grid extension with renewable energy. It concerns 150 000 families per year, and it costs $150 million US per year. The financial scheme shares the cost with all the partners - the electricity company, the urban population in a scheme of "National Solidarity", in which as all customers pay a 2% extra to support rural electrification. There is also contribution from local collectivities 20 %, and from users about 25%.

To date, nearly 4.500 villages are connected to the grid thanks to PERG. In addition, a large PV program will start as soon as possible. Morocco have tried during the past 10 years to develop a real service of decentralized rural electrification, using PV, wind, or other systems. We started at the needs level, and developed a global approach where we mobilize actors for development and private operators at the local level, if we are looking for sustainability.

We also look for simplicity of implementation, and adaptation of technical, financial, and social solutions to the environment, to the climate, and also to the sites. There is also a big effort to involve local human, financial, and energy resources. To give you an idea of the decentralized rural electrification pilot projects we've developed with French, German, and other co-operation, the following are presented.

Morocco had a large co-operation with the GTZ, reaching all aspects of renewables like wind, biomass, solar PV and solar thermal. This technical co-operation allowed us to go to financial co-operation, which we have from the KFW, as mentioned above. In Morroco, we have seen the evolution of public and private operators working in parallel with strong exchange. Public operators work on developing their own implementations, or implementations key in hand, or mobilizing the private sector for part of the service.

The market for next five years is around 10 MWp (200 000 solar home systems). The private sector works on marketing, networking, and developing high mobilization for the national program. Today, public and private operators meet around a service approach, preparing a new methodology to develop decentralized rural electrification. Another as-

Projet	Fonds Coopérat.	Fonds Maroc	Application
ERD-CE	10 Millions Ecus	30 Millions Dh	Nord
ERD-KFW	10 Millions Marks	45 Millions Dh	Tensift
PPER-France	30 Millions FF	70 Millions Dh	Azilal Erracchidia Safi
Village Power	8 Millions Dh		Chefchaouen Taounate
ERD-JICA	14 Millions US $		Haouz
Initiative PV de la SFI	5 Millions US $		Appui au secteur privé PV

Table 1:

pect of PV technology is water pumping - water supply, a very important issue for Morocco. The region have now reached very specific situation, in that we expect to have a lack of water availability in the near future, and we have to work very hard on this aspect. There is a national program for rural water supply, called "PAGER" but this program has met a lot of financing difficulties, because it's not something like electrification, where people are familiar with expenses for lighting.

The third aspect for energy for rural areas is the rational use of wood fire. We are working on strengthening use of gas butane, improvement of energy efficiency of equipment that uses wood fire, development of collective applications of wood fire and promoting of "ESCO" energy houses.

The "ESCO" Maison Energie or Energy Houses is a new concept to improve energy distribution in rural areas : appropriate energy services for PV electrification, gas distribution, improved furnaces, organization of installation and maintenance services near populations and near the need, looking for sustainable energy and environment preservation awareness for rural populations. With this project, employment, and strengthening local human resources in rural areas are also considered as important goals. We have 50 ESCOs under implementation. Some are already operational.

Rational energy use

Regarding rational use of energy, and trying to reduce the contribution to peak loads, we are starting a national program for solar water heater distribution. The markets assessment and analysis shows a potential for 400 000 m^2 to 1 000 000 m^2 and identify barriers as

- low reliability,
- high investment cost,
- lack of communications.

So , the new program is expected to improve the quality, reduce the cost, and develop regulations, and awareness through training, communications, etc.

Within the pilot phase, 1000 m^2 of solar water heaters are under implementation in the north of Morocco, as collective projects for public administration, like education, habitat, and health. With $4 million GEF support we expect to launch a 100 000 m^2 project by the end of this year, running during the next 4 years, for individual and collective applications, and for both rehabilitation and new installations. This program will generate $40 million investment. Taking into account all these projects, we could summarize in few words the actual situation of the renewable energy in Morocco: [quote this] Market for next 5 years, 250 MW wind park project, 10 MW PV for rural decentralized electrification, and around 100 000 m^2 for solar water heaters, Cooperation between private and public sector to promote technologies, develop standards, reduce costs (PV SHS is around $500per unit), Mobilization of important investment, with the help of GEF-PVMTI and other international financing institutions, Promotion of employment : 50 ESCOs by the end of the year, with potential for 1000 ESCOs.

Conclusion

The impact of energy-sector mutations on opening of renewable energy markets is very important, particularly for large scale projects like wind-parks and rural electrification. But the most problems/difficulties we meet concern the changes of implementation scale, the high cost of projects development, the risk of energy availability, etc. We could define three types of projects

1. Infrastructure projects,
2. technological projects, and
3. social projects.

For the first type of project the financial and institutional mechanism are already developed. But, for technological, environmental, and social projects, we still meet problems of sustainability of those mechanisms.

Renewable energy projects need fast financing mobilization, adaptation of criteria and procedures, and support to open the market and reach economic reliability. It's also very important to promote the service approach, and look for mobilization of financial and technical operators, preserving local expertise and strengthening the quality approach. Generally energy projects are decided 10 to 15 years in advance. It's time to have deep, and clear visibility on renewable energy possibilities to optimize planning program for energy in global aspects.

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The Moroccan Program for Rural Electrification

Jürgen Gehr

Introduction

First of all , I'd like to remind you that the PV market in Morocco has been successfully and essentially developed by some private companies like AFRISOL during the first half of the nineties. As already mentioned by Mr. Berdai from the National Renewable Research Institute / CDER, the National Utility / ONE established in the last years a large global program for rural electrification - the PERG - including the extension of the grid, isolated grids and SHS. For the PV sector, this meant hard times, essentially, because they announced subsidies for SHS without having an approach ready to be executed.

The new Moroccan PV approach

The PERG program is ambitious and will bring up the rural electrifcation up to 85% by the year 2006 compared to 20% at the year 1995. Some 10% corresponding to 280.000 households are reserved for SHS - naturally, in areas which need a high investment for the grid extension and where in same time the population will consume very few current. You may imagine that the 15% which are still pending and scheduled to be electrified after 2006, will have a higher proportion of SHS for the same reasons as mentioned earlier. Finally, after that painful period, ONE and the young industry represented by their professional association AMISOL were sitting together and prepared the first big tender which has been released at the end of this summer and is now under evaluation.

The approach discussed between the solar industry association and the national utility is very exciting and new - I haven't seen a similar approach anywhere else in the world. It is the intention of ONE and the private sector to maintain competition between the awarded companies and for this reason no regional protection will bare the route that in regions with a high potential of customers several companies will offer their service. The winner of the first bid will be awarded with subsidies for 16.000 households. Companies which passed the technical and financial evaluation will be attributed with subsidies for 8.000 households each, at the condition that they aline their price offer to the winner's one.

A subsidy of 430 USD covering the hard ware cost of the basic 50Wp SHS, will be paid by ONE to all customers which are inside the so-called solar zones. In order to allow the population with the lowest incomes access to an electric service, the tender is based on a fee for servicing cells, which means that the customer will pay a down payment to cover the costs of the electrial installation inside the house and a monthly fee which includes the replacment of all main components, over 10 years. During this time the operator is fully responsible for the whole system. This stems from experience in which companies tried only to earn easy money and disappeared after two or three years, leaving people in the countryside stranded, not knowing how to proceed. After this period the end users become owners of their systems.

The service provider is charged with the marketing in the solar zones, but he is not limited to commercialise only the basic SHS on a fee for servicing base. On the technical side, there is no limit to upgrade the system's power or to switch to AC systems as long as the technical specifications are respected. Various finance schemes as cash or credit payment are allowed after approval from ONE. But all approaches have to be linked to a service and maintainance contract to assure sustainability. There the competition will be mainly based on the quality of the operators services, which is quite fair towards the end users.

Already now, the Energy Ministries from countries in our part of the world are visiting Morocco to discuss their experiences with ONE and AMISOL. In same time, they have invited the leading Moroccan companies to transfer the acquired know-how into their home countries, convinced that they are more familiar with the conditions in the countryside than companies from Europe for example.

PV technology in Morocco

I heard some questions about technology transfer, which is an important subject for developing countries. But let me first talk about the transfer of knowledge which PV system assembling companies has experienced in our country. PV components are developed by people who have little idea about the conditions where these items will be installed. Having uneducated end users means developing devices which are very reliable, rugged, easy to use and to maintain. As well, the installers do not have a high level of training to understand manuals which seem to be made for the university.

I can advise and invite these companies, to develop and test their new products hand in hand with local system assembling companies which in the end is profitable for both of them. Another effect is that you will improve the reputation of your company and your products, because people identify the result with the company and not with installation procedures.

Regarding the new challenge of our profession to develop and to introduce pre-payment systems to master maintainance and collection of fees from thousands or ten thousands of end users, there will be no other way to be successful than to cooperate closely.

Morocco has a small industry for production of electronic devices and a larger industry for battery production. Most of these companies do not have the financial capacity for research to improve their products. An opportunity exists for your companies to conclude partnerships, either to complete their range of products or to produce partially directly in the country. You will profit from a better market understanding and penetration, as well as improvement as an investor in vital market segments and the image of your company in the country.

Thank you.

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Session II

Appropriate Renewable Energy Technologies

Solar Home Systems for Rural Electrification - The Case of South Africa

John van Laarhoven

Introduction

I'd like to explain the 50.000 solar home project in the Eastern Cape of South Africa project, as the chair has explained.

Prior to that, as an introduction, I'd like to tell you a bit about Shell solar and rural electrification from their perspective. If I could add something to the speech of Mr. Holm, I would gladly do that. Thirdly, I'd like to address the South African rural electrification market. I'd like to talk a bit about the system we have on the offering called the "Powerhouse" system, give you the Eastern Cape project status, and draw some conclusions with you.

"Jenza" is a Zulu word, which means "just do it – get on with it". In a number of speeches today, I heard the words "demonstration", "research", "study", etc. I don't think the two billion people that have been on several occasions are waiting for more studies; I think they are waiting for initiatives – to "just do it" on a large scale. As Mr. Gehr pointed out, in Morocco there is a program of 200,000 customers, and they're running it.

Shell solar and rural electrification

The two billion people have been often addressed today. The other day I heard Mr. Wolfenson speak about the fact that in the next decade another two billion people can be added to the existing two billion, mainly in developing countries.

A lot of governments have proclaimed "electricity for everybody". As also addressed by our chairman, the traditional grid is, in many cases, too expensive or not feasible because of the very limited demand by a number of rural households, and also because of the costs involved with the very dispersed nature of that market. As Mr. Miller has pointed out, there is a huge lack of financial institutions and infrastructure in rural areas. Another thing that became clear today is that standalone PV systems are commercially feasible, and as Mr. Beradi already pointed out, a PV gap will assure that PV and solar home systems will really be used in remote locations. Shell solar sees it as it's mission to electrify the world's rural, non-electrified population using renewable energy with proven technology. We think we can achieve this by focusing on the customer's needs – looking at affordability, necessary infrastructure in the rural areas, and thereby develop a viable commercial infrastructure.

These are the projects we are currently involved in:

- In Bolivia, the Philippines, and China, we are currently executing and/or preparing projects with subsidy assistance from the Dutch government.
- In India and Sri Lanka we have set up solar companies.
- In Ghana we are setting up an initiative with allied Dutch PV industries.
- We have a share in a company in Morocco.
- The South African Eastern Cape project, which is today's subject.
- We have a distribution network with Shell Solar in Brazil.

Background on the South African Market

The unelectrified part of the population – I believe Mr. Holm spoke of 2.5 million households – is our target market. As far as grid expectation is concerned, it's hardly feasible to electrify these deeply rural areas. In numerous areas in South Africa, the people are very dispersed and are very difficult to access.

There is also no access to finance. However, these people spend in the vicinity of the equivalent of five to fifteen dollars per month in local currency to provide for their energy needs; candles, kerosene, paraffin, batteries and such. There is limited experience available, in spite of the large number of studies that have been done, from actual previous projects. The experience that is available, however, shows that problems with getting your money back are mostly in the form of theft and tampering with equipment.

In South Africa, we enjoy the full support of the Department of Minerals and Energy (DME). We launched the project roughly two years ago with the following objectives:

- To prove a project like this could have commercial viability.

  This is why Shell and ESCOM both decided to put equity on the table, and show to the financial world that if you are willing to invest in a project like this and set up a good infrastructure, you will get your money back.

- A two stage approach. Stage one is six thousand units implemented in one year.

  This stage was launched in March 1999 by former President Mandela, in his Natal area. We wanted to make sure the offering met the customers' requirements in terms of functionality and affordability. If you consider the market as a pyramid, and don't focus on the 5% who can pay cash, and concentrate on the lower income in the central part of the pyramid, you'll find the target group we took into account for this project.

- To maximize local content. This is particularly true for supply, because in South Africa, there are two worlds. The is a third world, but there is certainly also a first world. Batteries from South Africa are excellent. Conlog, a company with whom we work, is by far the largest manufacturer of electronics in the southern hemisphere.

- A "fee for service" concept. We do not want to sell the systems; we want to sell the service of having electricity to these people.

I was approached earlier today, by somebody from the audience, who asked "but what if people who are paying this fee decide to go on leave for two weeks?". I'd like to compare that with the analogy Mr. Miller used, where in the Western world, people can, on the basis of their character, buy a car and drive it home with no payments. This person must still pay for their car, whether they drive it or not. This is exactly the setup we've chosen in this project.

Description of the product

The system makes use of a solar module, a pyramid-shaped battery, and a controller and user interface. There are a number of outlets present. We supply the system inclusive of the total cabling, plus four lights – three interior and one exterior. Furthermore, the opportunity exists for the customer to connect a 9V or 12V radio, and a television.

We have made the system completely foolproof. In deep rural areas, we must work with people who are practically illiterate. We have tested the system by having it installed by people who normally tend herds, and they could do it in two hours. The connections are totally plug-and-play.

We use lights with reflectors, manufactured in this beautiful country, and of extremely high quality. The average bulb lifetime is 10.000 hours. This company is absolutely certain of the quality of their product, and gives us a back-to-back warranty of 5.000 hours.

The user interface has two lines of symbols. The yellow ones indicate the battery system's state of charge. The white ones indicate the number of days credit left in the system. A small light will cycle on for exactly 100 seconds; during that period, an LED will indicate the battery status. A second LED will cycle on for the next 100 seconds, and credit status (remaining days) will be indicated. To make sure people know when credit is low, during the last week of credit the LED will be red and blinking.

Exact current from the solar module to the controller, and current from the controller to the loads, is indicated by number of pulses from a corresponding LED. Divide the number of counts by ten to get an exact measure of current. This makes maintenance diagnostics very easy. Of course, we have training aids, manuals, and all other necessary materials to instruct people.

The system provides 200 W·h per day, on the basis of five equivalent sun hours per day. All outputs are protected against short-circuit, overload, polarity reversal, etc., and we've built in load shed mechanisms. With the 20 Ah available in the system, you could run four lights for three hours, or the outside light for ten hours and a couple other lights for less. There is enough energy to watch a 35V television for a three hours, with radio for several hours, and twelve hours from a single light.

I commented earlier on theft of systems. Apart from theft of solar modules, it's also a big problem if someone tries to start a car with a battery designed for solar applications. We certainly don't want that to happen. We designed and implemented a "smart switch" security device into the solar panel and battery. If the battery is removed from the solar unit, the battery stops being a battery. If the smart switch is accessed, and an attempt is made to bypass it, the protector will be destroyed.

Another feature is the pre-payment. We have a co-operation agreement with Comlock, who have supplied over 2,5 million prepayment meters to ESCOM, and they are very experienced in pre-payment. I should point out to Mr. Gehr that the magnetic cards used for the pre-payment are single-use magnetic credit tokens, and they are by far the most attractive solution from a cost point of view. Monthly payments ensure full availability of the system. The system can provide 200 W·h per day with an autonomy of three days. If a payment is not made in time, the system stops operating. For example, if a customer buys a payment for January, doesn't use it for February, and buys a token in March, the system first subtracts the time from February before crediting March. We can have flexibility on the time basis, and the tokens and the systems are uniquely coded to prevent fraud. Put simply, we can have unique codes in one community different from another. The partners in this project are ESCOM and Shell; we've established a local joint venture company, and Comlock and Shell, for the world-wide marketing and distribution of that product, and a product line to follow.

Distribution and Support

We have also established an organization we call an ESCO, not unlike the Moroccan organization of the same name. ESCO stands for the "Energy Service Company". It is a company well adapted to the first world environment, and makes use of all modern communication means. An ESCO would make use of a number of RESCOs, "Rural Electrification Service Companies". Such a company can be compared with the local supermarket in a larger city for a given region of the Eastern Cape. These people would also take care of stocking materials to be further distributed into the rural areas. Each RESCO would have contact with a number of outlets. An outlet would ultimately have a maximum of 200 to 250 customers in their community. The approach of outlets is in combination with the RESCO, and goes via the community hierarchy, and all rules are followed. This way, we have buy-in of the community itself.

A RESCO would also have skills available for sales of contracts to end customers, financial management, training for installers who might be part of the user community, and technical management.

The monthly payments cover free maintenance of the equipment, free exchange of the light bulbs, and of course, the capital cost of the systems. We think that this will provide a sustainable business which might generate an easier access to funding.

As for money collected, we charge about $25 to the rural customer to cover installation, up front sales cost, and promotion costs. 30-day tokens cost about $8. The outlet sells tokens to the end customer in booklets. This means that a rural customer will buy a token, then the token will be placed in a booklet not unlike that used to store business cards. Since modern communications are scarce in these rural areas, this is one of the only ways to do this securely. Security concerns are also why we don't want outlets to have more than about 200 customers, as the incentive for theft would be too high.

Incentives are in place for the outlets and their sales of the tokens, and also for the installers, maintenance crew, RESCO, and ESCO.

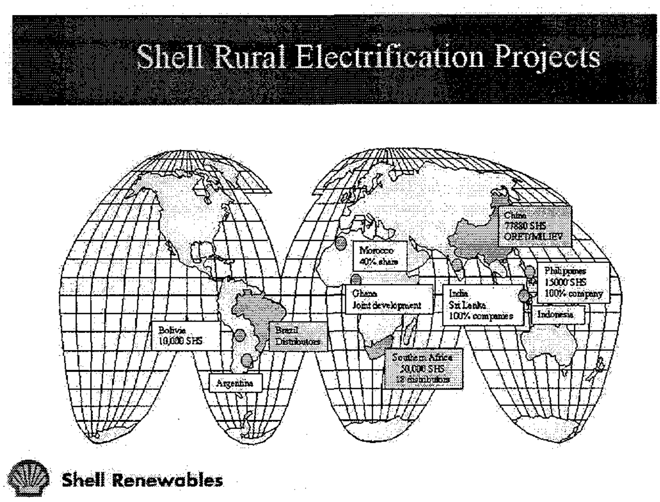
A typical outlet is called a "spaza shop". We've set it up so that all the outlet owner has to know is that a token has been given, and some cash is expected in return. Still, you have a customer database somewhere that follows the transactions of 50.000 payments. Therefore, a number of other things must also be done.

We initially projected that the first 6.000 units would be installed by December 1999. Unfortunately, it took longer to start up the organization and go through the learning curve. Ultimately, we succeeded in December through February to install over 1.500 systems per month in 180 communities. So, the current project status is:

- The local organizations are in place and selling in 180 communities
- We have 370 installers trained who will be re-trained as maintenance people.
- We have sold 6.000 contracts in eight months.
- We have a 100% installation fee collection rate, and 98% revenue collection in the first year.

We have pre-set criteria for the project in order for Shell and ESCOM to go into financing of phase two. The fourteen criteria points are reviewed by a technical review, financial review, and a marketing review. The financial and marketing review are under way as we speak, and the technical review shows that the project meets all criteria.

However, we need a customer database. By the time we have 50.000 transactions on the ESCO level alone, on the basis of sales slips given in by possibly illiterate villagers, it would take about 1,3 months to produce a report, whereas you would want it in the first three days. We decided that we would have a need of combining a customer database with a bar-code coupled with the hardware, linked to the GPS location of the customers.



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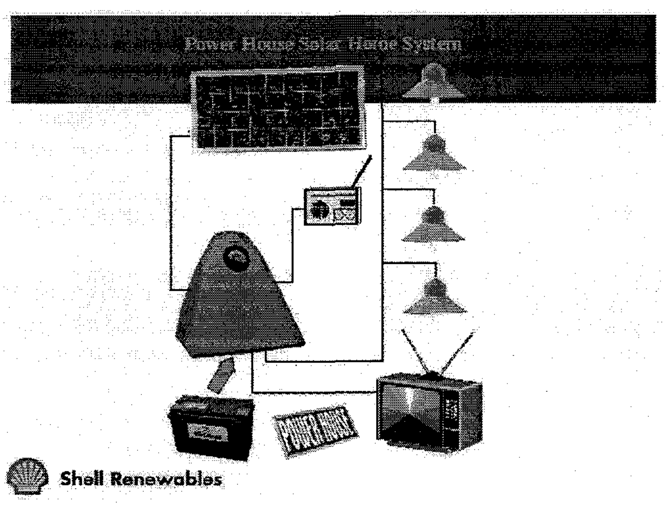

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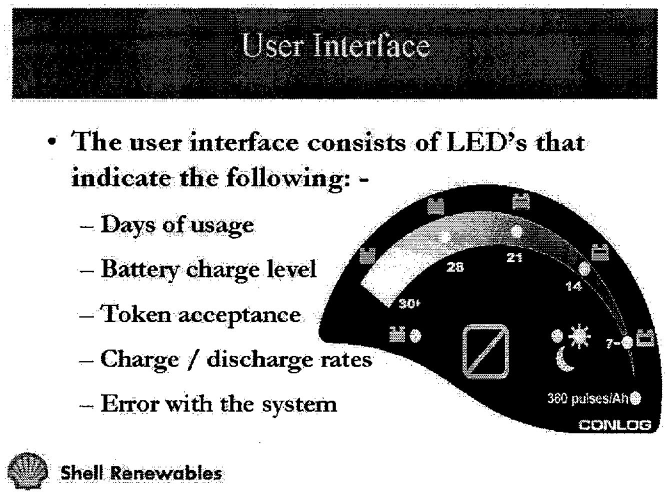

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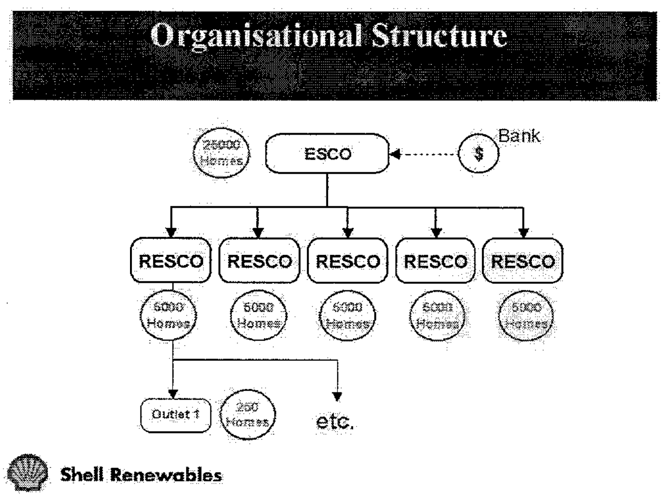

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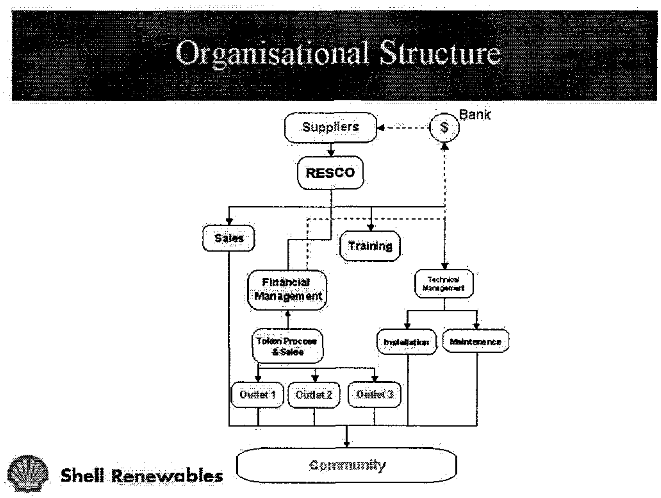

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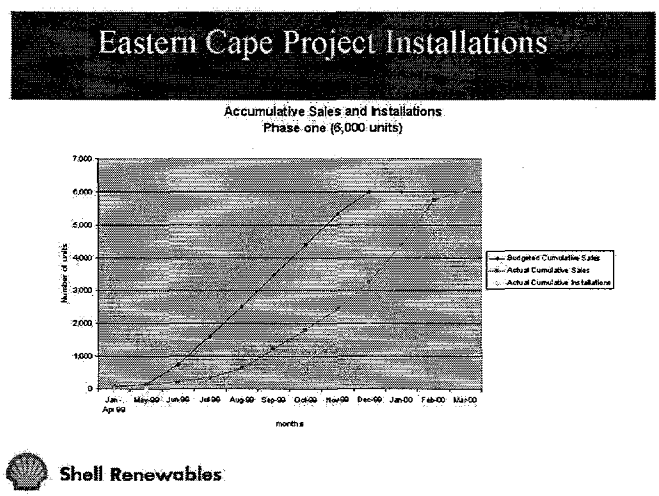

Figure 6:

Conclusions

We have an adequate local organization in place to cover the 50.000 rural customers, a strong community involvement in the project, and political goodwill with ESCOM the DME. We think that Power House is an attractive and financially accessible proposition to rural customers. We've done 6.000 in 187 communities. In phase two, we will implement a customer database. Currently the revenue collection is better than 98%.

Thank you.

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Photovoltaic Hybrid Systems - Energy Supply for Villages

Klaus Preiser

Introduction

Photovoltaic electricity - inexhaustible, clean, available everywhere in the world, modular in low power quantities - is an ideal option to supply rural areas which are not yet electrified. Nevertheless, two decades had to pass after the first demonstrations of solar technology in the seventies until stable markets with high growth rates developed in different parts of the world for one specific technical solution for rural electrification, the Solar Home System. Indonesia, Mexico, Morocco, Kenya, China and India are excellent examples for the establishment of such markets. Today we estimate that e.g. about 200,000 Solar Home System units are sold annually. The total accessible user potential is valued at up to 100 million units. Further applications like photovoltaically powered pumping systems for drinking water, photovoltaic lights, photovoltaically powered battery charging stations and hybrid systems for power supplies in hospitals, farms or hotels have found wider dissemination as well.

Rural electrification in developing countries

The access to grid based electricity in rural areas of many countries is clearly insufficient. The electrification rate of rural households ranges between 5 % (Central Africa) and 25 % (Latin America), leaving more than two billion people of our world without the modern energy services of electric power. That this absolute number has not changed much during the past two decades can be seen in figure 1, where the electrification rates for different regions are summarised.

Rural households have low power consumption and low income. Investment costs for grid extension on the other hand are high at a world-wide average of 900 US $ in 1994 prices per household [ASTAE 1996, Foley 1990, Foley 1995]. The return on investment for rural grid based electrification, as a consequence, is low. In many situations payments for the electricity provided do not even cover the maintenance costs of the distribution lines. This leads to a poor economic performance of power utilities and bad quality of the energy supply. As a result, annual worldwide expenditures for grid based rural electrification fell between 1981 and 1990 by 50 % to about 7 billion $. Grid based electricity in rural areas is used for a complex set of tasks: it is used for a wide scale of commercial and agricultural activities, it is used in the public sector for telecommunication, drinking water provision, health services, schools and street lighting and it is used, last but not least, for private household lighting, information and entertainment and household appliances. In the following, this paper will focus on the application of electricity in private households. Recognising the limits of grid based centralised power supply, we will address the question: is there a solution based on solar energy which is superior to the candles and kerosene lamps, to the dry cell batteries or car batteries for radio and TV used in

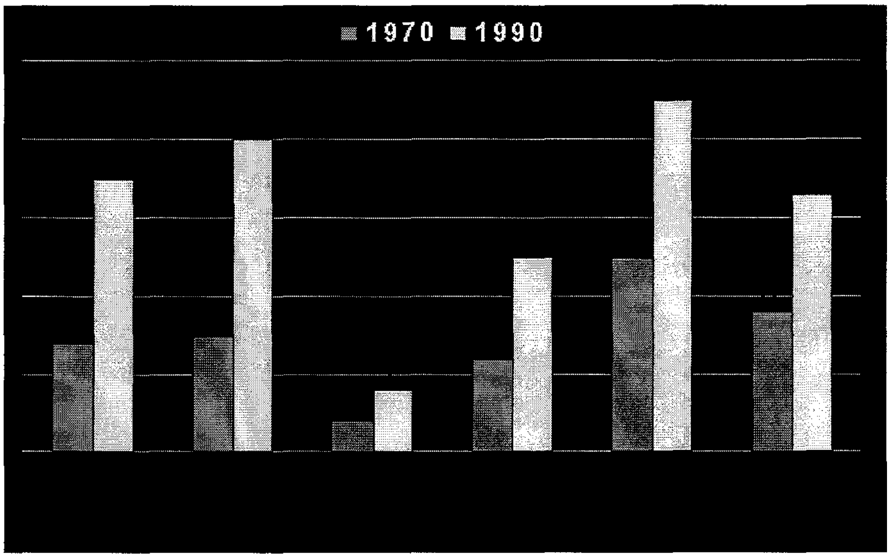

Figure 1: Electrification rates of rural households in the years 1971 and 1981 [Worldbank 1996].

non electrified rural households today.

The Solar Home System as a small, individual solution

The designation "Solar Home System" has become a well-defined concept. A 50 W photovoltaic module typically supplies power for three lamps and a black and white television in a single household. A lead-acid battery with a charge controller stores the energy from the day for the night and tides over two to three overcast days. Depending on the size of the local market, customs duties, taxes and the share of locally manufactured components, the cost of a Solar Home System is between US$ 500 and US$ 1500. Under favourable conditions, Solar Home Systems offer cost advantages over the classic alternative for electrification, the extension of electricity grids into sparsely populated regions and connection of power lines to all rural households. The World Bank assesses the average cost world-wide of grid extension to be US$ 900 per household. In unfavourable cases, with long distances, difficult terrain and low population density, a power line for one household can cost many thousands of dollars.

The investment needed for this cannot be financed via the low energy consumption of rural households, which ranges between fractions of kilowatt-hours and a few kilowatt-hours. Political decisions to electrify rural areas despite this imbalance have contributed to electricity utilities becoming indebted in developing and threshold countries, so that necessary investments to modernise distribution grids and power stations cannot be financed. The result is the poor quality of the electric power supply, which can be observed in many regions around the world. Increased privatisation of the power supply is intended to provide a remedy to the described situation. Decentralised electrification with privately financed Solar Home Systems fits in perfectly with this aim and is therefore actively supported by the energy planning authorities of various countries and by multilateral organisations such as the World Bank, see figure 3.

Light, allowing information and communication for private users, light, which lengthens the working time into the evening in farms and shops, schools and community centres, cannot be underestimated in its importance. Solar Home Systems can provide this light. Electricity also solves other supply problems. Workshops, food storage and processing, infrastructure tasks in health services and administration, and the development of tourism demand higher daily amounts of energy and power than can be supplied by a Solar Home System. The next electrification stage consists of larger individual systems and then lo-

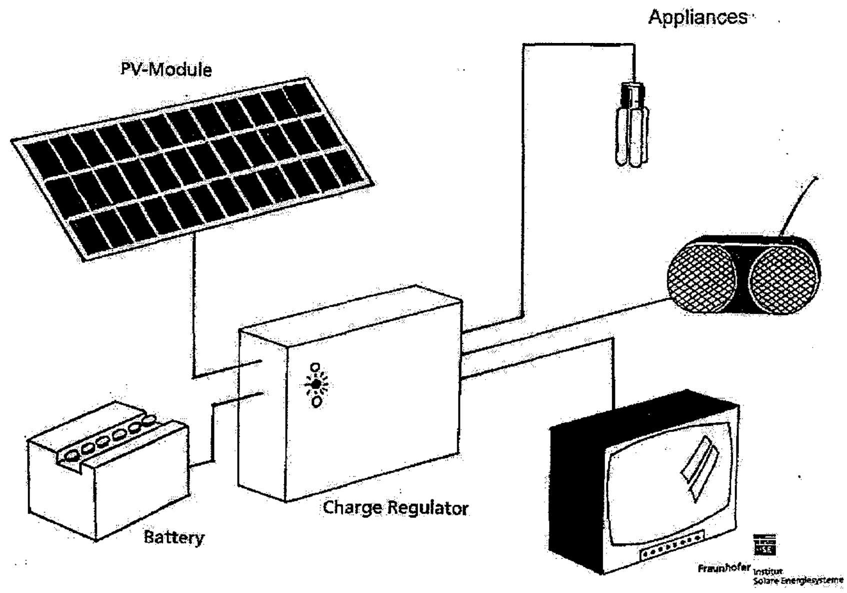

Figure 2: Solar Home System - individual power supply for single households.

cal networks.

Hybrid systems for power supply in the kilowatt range

The usual supply levels, classified according to small and medium loads, and local, regional and national supply with the corresponding voltage levels and power ranges, are illustrated in figure 4. Photovoltaic power technology is cautiously expanding into the range "supply of small and medium loads" at present. To increase supply reliability (backup with different generators), or to reduce the investment for very large photovoltaic arrays or very large battery storage units, systems to supply daily loads of several kilowatt-hours or more are typically constructed as hybrid systems: a diesel generator, a photovoltaic generator and possibly other generators for wind energy or hydroelectric power complement each other in supplying power. A battery bank and possibly other units for short-term energy storage ensure that power is available at all times. Power is distributed to the loads with AC voltage of the usual frequency and amplitude.

The concept of hybrid systems is not new. During the past two decades, several hundred hybrid systems were constructed, operated and evaluated with the support of the German Federal Ministry for Education, Science, Research and Technology BMBF and the European Union EU, European utilities, and national and international funding bodies, also on other continents.

Hybrid systems should meet the following power supply specifications [Bopp, 1997].

- continuous (24 hour), highly reliable power supply with single-phase or triple-phase AC voltage.
- provision of sufficient power to operate electric motors.
- Compared to a diesel generator, which is operated on demand for several hours a day, a hybrid system should:
- considerably reduce the fuel consumption, the number of operating hours and thus the replacement and maintenance costs for the diesel generator.

Many of the installed systems have successfully met these goals. The technical feasibility has been proven beyond doubt. However, there are still unanswered questions regarding larger hybrid systems, more obviously so than in the case of the Solar Home Systems discussed in the first section.

Figure 3: Sukatani, the first SHS pilot village in Indonesia, was the origin of the currently running 50 MWp programme to electrify one million rural households (Photo: Fraunhofer ISE)

Configuration alternatives for photovoltaic hybrid systems

The majority of lower power hybrid systems now installed falls into one of the two following categories: DC-connected systems or AC-connected systems (figure 6 and figure 7. The system illustrated in figure 6, with the input energy flows connected on the DC side of the inverter, has proven its functionality in many systems installed in the field. Reliable components are commercially available. However, the need for individual charge controllers, or rectifiers including a charge-controlling function, can lead to systems with relatively complex structure and thus to higher investment costs.

Concentration of all load flow control tasks in a bi-directional inverter, as shown for the system in figure 7, can lead to simpler system structures. However, at present only a few inverters are available on the market, which have proven their reliability in operation and could be used for this complex task. Therefore, it is not yet possible to compare costs for both concepts on the basis of field experience.

The concept of AC connection can be developed further, if the photovoltaic generator is also equipped with its own inverter. Then the photovoltaic power would also be fed into the AC side of the bi-directional battery inverter.

Village Power Supply systems

While Solar Home Systems for the decentralised power supply of rural households are considered to be a standard system, ready for the market, and while the suitability of PV hybrid systems to power single houses has been proven in various pilot and demonstration programs all over the world, this positive experience is up to now not available for central power station to supply remote villages with off-grid PV power. Nevertheless is the research and development in rural electrification more and more directed towards theses systems. The main reason is, that with a central system, installation and operation costs may be lowered compared to the single house supply option. As today more and more electric utilities enter the off-grid market, their interest is to lower as much as possible the cost for operation, maintenance, money collection etc. needed to assure a durable energy service. Experience, and reports from those having been involved in PV dissemination programmes for rural electrification, confirm that technical problems in the village supply are not the main barrier which prevent lasting success. Rather, an appropriate intro-

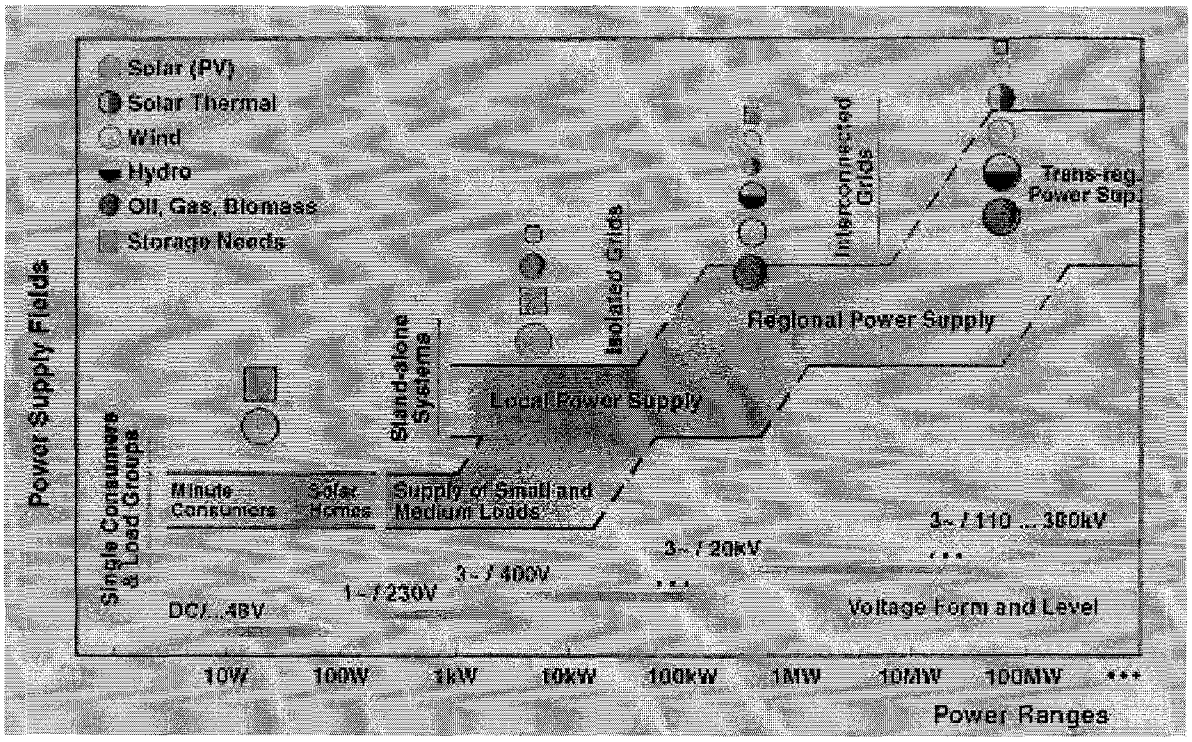

Figure 4: Classification of power supply technology for electrification with renewable energy - energy sources, application classes and trends. [Kleinkauf 1996] 0.7

duction method, user involvement at various levels, and planning which allows flexible reaction to the situation as it develops, are necessary to achieve optimal joint use of the limited resource. Today there are technical components, like inverter, charge controller, energy management systems, available in various countries, that are much better suited and matured, than they have been in the early demonstration projects. The R&D efforts in the development of village power supply systems are now focused on the fair distribution of the energy available, and a suited limitation of the power consumed by each single household. Prepayment schemes or energy limiters, that are metering energy consumption in each single household and cutting the load, if the pre-set values or the energy budget has been consumed are in development and demonstrated in several companies and international pilot programs. A typical representative is TRANSINDO, the French-Indonesian project on village power supply of four remote villages in Indonesia, each consisting of 300 to 400 households, The use of a specially designed energy payment meter shall guarantee, that the different users can adapt their energy behaviour to their needs and their economic capabilities.

Cost of energy service at the example of Solar Home Systems

In figure 8 left side the cost breakdown of a solar home system in the first year is presented on the basis of data available in a project on rural electrification carried out by the German Agency for Technological Cupertino GTZ GmbH. As it is expected the installation costs, i.e. mainly the purchase costs of the different component are the dominating factor. The photovoltaic module typically represents the major single component of the system costs in the first year, including system installation and project management [Preiser 1995].

Considering the cumulative costs after 20 years however, the proportion for the PV module decreases to 10-15%. The costs for battery

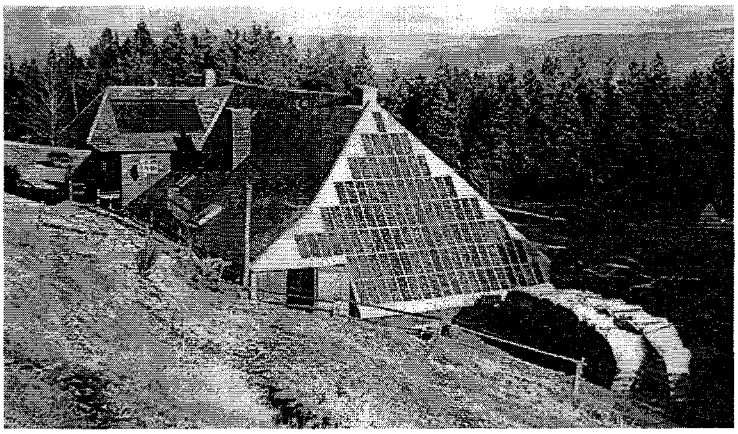

Figure 5: The Rappenecker Hof. A power supply for the hikers' inn in the Black Forest, consisting of a photovoltaic generator, a wind energy converter, a battery bank and a diesel generator, started operation in 1987 (Photo: Fraunhofer ISE).

replacement as well as the efforts for maintenance and repair become the most important factors. The reason for this shift in the cost distribution is the difference in the quality and reliability of the different components. PV modules are highly standardised and world-wide validated certification procedures have been established, both leading to high-quality components. Up to now, no equivalent measures have been available for the balance of system components (BOS), i.e. battery, charge controller, installation material and the electric appliances. As a system is always only as good as the weakest link in the chain, the quality of these components influences the whole system. Users are not interested in module efficiency or generated ampere-hours. They desire a certain energy service, which is dramatically disturbed, if components like an electronic ballast or the charge controller fail. To achieve highly reliable systems, recommendations for the quality improvement of Solar Home Systems and their components have been prepared in different institutions together with industry partners world-wide and are currently being introduced and implemented in national and international standardisation committees. To apply this in the practice of the currently applied market introduction schemes these quality criteria have to be further developed and adopted by the relevant partners in developing countries. Testing procedures adapted to the local capabilities and needs must be worked out and suitable "centres of expertise" to carry out detailed tests must be established. An overview on the quality criteria to be met is given in figure 9.

The guarantee of high quality standards is seen as a main necessity to bring in financing agencies and companies. Up to now, the risk, that is due to the uncertainty about the durability and the handling of PV systems can be identified as one of the main barriers for bank, insurance companies, private fee-for service providers, governments and last but not least the users of the systems to becoming involved in this new technology.

Technical quality aspects during the implementation of PV stand alone systems for rural electrification

Certification of components and certification of systems will be an excellent basis for the qualification of PV stand alone systems for rural electrification. As described above various national and international activities are under way to find globally accepted standards for Solar Home Systems. For a successful implementation of Solar Home Systems in rural areas however further activities and more partners are involved. In the following the role of local manufacturers, local test laboratories and financing bodies are described [Gabler, Preiser 1998].

The role of local manufacturers

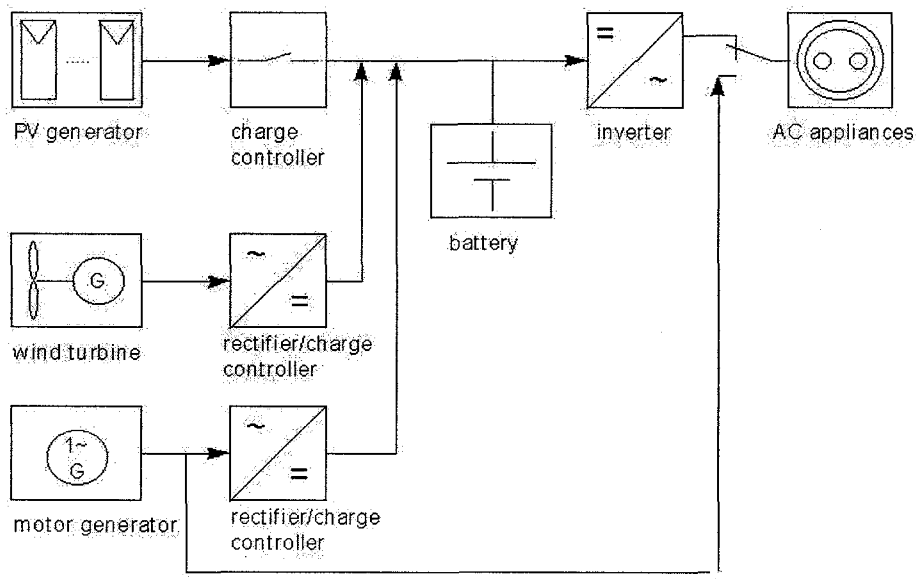

Figure 6: A DC-connected hybrid system with a PV generator, wind energy converter and diesel generator.

The main components of small PV-systems are the PV module, the storage battery, the charge controller, if necessary a DC/AC inverter, the appliances (lamps, radio, TV sets, refrigerators, fans etc.) and the installation material (safety boxes, cables, plugs, sockets etc.). While today and at least in the near future, the PV module will be imported from industrialised countries - in some developing countries the module assembly already started - all the other components are suited for local production. Of course these components have to fulfil the high quality standards as well which are needed for all components in a PV-system. This is the reason why in today's' larger PV programmes for rural electrification often components from industrialised countries are used. However, there are several reasons for the assumption, that in the near future - and in reality this development has already started in many countries - good quality components will be produced locally. The proximity to the markets, i.e. close matching with the users' needs and desires, the lower price of the components due to the lower expenses for manpower and the better commercial situation (no import barriers), the ability to repair and replace faulty components very quickly and the promotion by local governments show clearly that there is a large potential for local production. Today many local manufacturers work in joint ventures with industrialised countries which may bring benefits for both sides, quick establishment of a production line of high quality products for the local partner and increased market shares for the foreign partner. If local producers make wise use of international and national quality rules and quality control bodies, they will increase their market competitiveness considerably.

The role of local test laboratories

The same arguments, which speak for the local manufacturing of components are valid also for local test laboratories. Price and proximity to the market accelerate the acceptance of such an institution in the respective countries. However, for the acceptance by local and foreign manufacturers, total in-

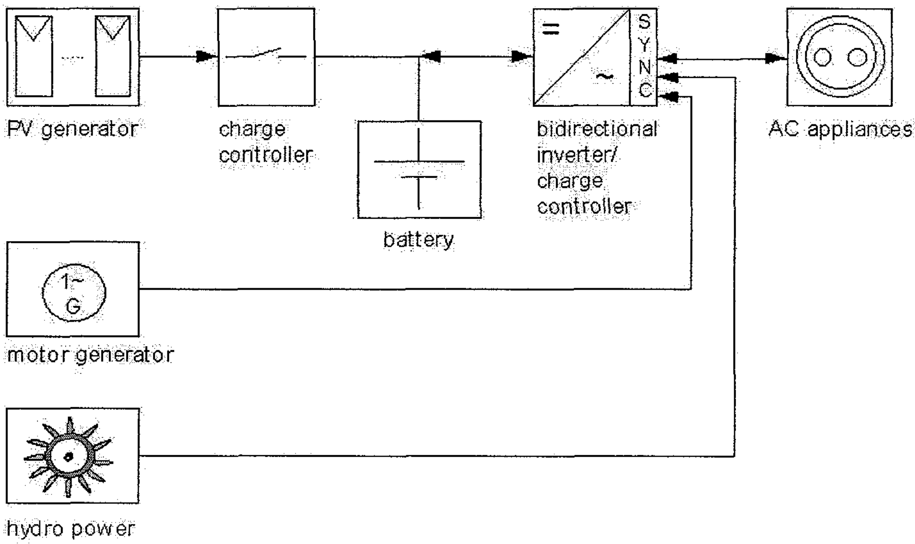

Figure 7: An AC-connected hybrid system with a PV generator, hydroelectric turbine and diesel generator [Preiser 1997].

dependence has to be assured. The success of local test laboratories relies strongly on the reputation of the staff and the quality of the managers involved. Quality assurance of these institutions (accreditation) can be achieved through foreign testing bodies or international organisations, like IEC, TÜV or others. As mentioned before the complementation of international norms and standards for local conditions is desirable and very often a prerequisite for the acceptance of these rules by manufacturers and users.

The role of quality control for financing bodies

PV-systems have a high investment price, while the running costs are normally lower than those of the conventional alternatives. To overcome the barrier of high price for low-income customers, commercial credits or financing systems are used all over the world. Therefore financing bodies will play more and more a key role in the dissemination of this new technology into rural areas. A basis for all decisions of financiers is the degree of risk they have to face when entering the playing ground. While national and international bodies have realised, that PV-systems for rural electrification may be good business in the future, today most financiers postpone the decision to get engaged with this new technology. To increase confidence, technical specifications and quality definitions, best represented by an internationally accepted quality seal, as well as positive experience in pilot projects are needed. Here also a wide field opens for organisations of international co-operation and international lending organisations, like the World Bank.

User involvement

Experience with PV systems, that has been gathered at Fraunhofer ISE for more than 15 years, shows that besides technical quality, the operators and users of the system play an important role in the long-term performance and appreciation of the technical system [Preiser, Schweizer 1995]. The people involved have ideas about the design, ad-

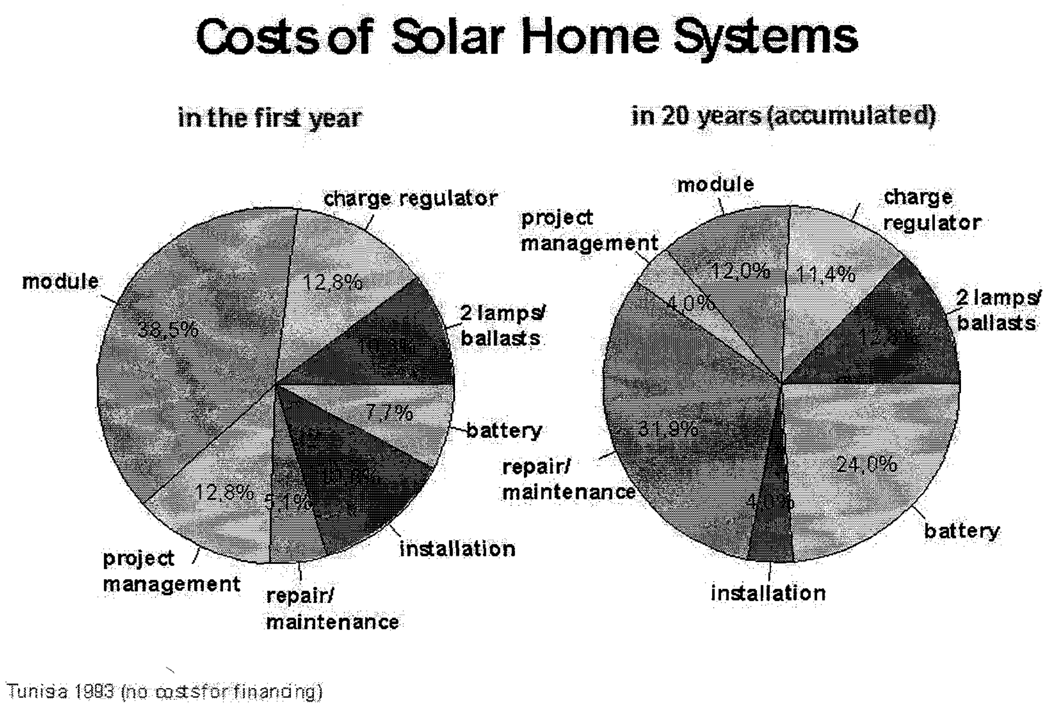

Figure 8: Cost breakdown for Solar Home Systems [Njaimi 1992]. Left: year of installation. Right: accumulated over 20 years of lifetime.

vantages and disadvantages of the PV system. The behaviour of the users influences the system's performance tremendously, because they: purchase special components, sometimes install and/or change the system, use the energy, organise the maintenance and repair the PV system (or neglect to do so). It is evident that the functioning of PV Systems can be optimised if the interaction between the new technology and the new users can be improved. From this assumption, at Fraunhofer ISE we developed a user-centred approach on rural electrification, called "socio-technical system approach".

The socio-technical system approach originates from work and organisational psychology and was applied first to labour organisations in Europe. When new technologies were introduced, it was found that not only the technology has to be designed according to the needs of the organisation, but also the social organisation needs restructuring to increase the productivity [Sheridan 1981] The approach is based on the open system theory [von Bertalanffy 1949] where the introduction of technology consists not only of hardware and software but also of orgware [Butera 1989], the human part of the socio-technical system. This approach has now been transferred to the use of PV systems, although their purpose is basic energy supply and not primarily production. In the open system theory, a target system is defined, that may be further divided into subsystems.

The individual, who interacts with different components of the SHS, is in the focus of the concept. Due to the fact that it is not a closed system, the levels above - e. g. technical components available in the country, maintenance work done by the village technician etc. - play an important role; as described earlier. A properly reflected energy concept in the planning phase is the basis for the system design. But it is not only the quantity of components and their power consumption, that finally determine the energy consumption in the PV system: The users have a decisive influence on the energy consumed, on the energy management done to optimise energy available form the PV gener-

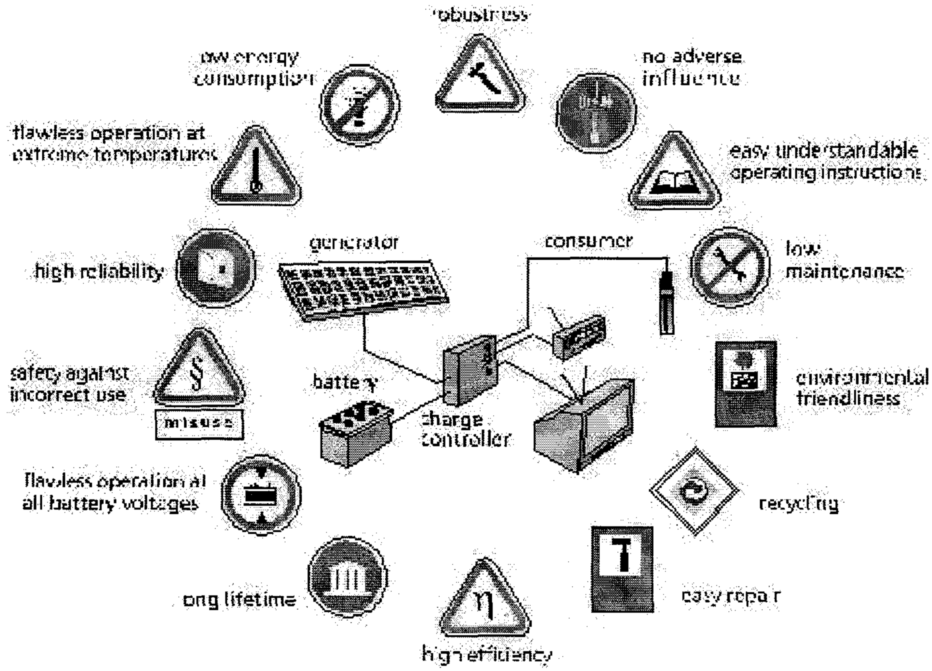

Figure 9: Summary of quality criteria to be met in stand alone PV systems [Preiser 1995].

ator and their energy demand and they are the first level of maintenance (cleaning the PV module, re-filling battery water etc.). Therefore involving them in the operation of the PV system, making them responsible for operation and maintenance is not only a measure to reduce the costs but also increases their own satisfaction with the energy service provided. The methodology and the results achieved are described in detail in [Parodi 1995], and [Parodi 1998]

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Small Hydropower - Clean Energy for Villages

Andreas Hutarew

Introduction

Hydropower is one of the most challenging energy resources. The Community of Globe decided hydropower as one of the tools to reduce the carbon consumption worldwide and protect our natural resources.

background

Many of our so called developing countries have a high developed know-how potential within their countries. The question must be put, which technological transfer and cooperation can be helpful? Other lectures given in this congress highlight potential and general mechanisms of transfers. I would just like to remind our political institutions that only their support in an efficient way will enable industries for success.

My personal relation to India and Nepal will demonstrate powerful capabilites growing from local resources, topped by international expertise.

Let be frank - expertise means reputation and respect at a same. And lets be honest - I found remarkable expertise in India, but as well the wish from governmental bodies and private investors to be secured for quality by international experts. Obviously the right mix of local capacities and international expertise grant for quality and trust and therefore success!

Basics of export

Everybody knows that a good product is the base for a successful export activity. The best product is the one that meets the demands of the targeted area. Our product - energy supply; in your case -renewable; for a small hydro is needed everywhere.

The major restriction is availability of water and non-violation of environmental aspects.

To specify more, the physical parameters viz head, the discharge, efficiency rate and grid situation for evacuation compete with legal procedures like approvals, clearances, private interests and environmental protection rules versus the financial setup, international support, Power Purchase Agreement and of course amortisation period are of paramount importance. It is our obligation as advisors to create the necessary trust and acceptance with those organisations being involved or affected by the impact of establishing the hydropower and to mitigate between the parties involved.

In fact it does not matter, whether we are growing a small or a huge hydro project. The expertise level must be comparably high and the link to the local community must be firm and stable. This fact, unfortunately, is quite often not properly considered.

Thus we come to our conclusion No. 1 that the healthy mix of local and international experience makes the foundation for successful export activities. There is only one difference: Whether we provide software or hardware supplies or advisory services.

Its a small difference that makes success

Entering the market in new regions is exciting, challenging and risky at a same. All company owners are fully convinced and satisfied with their own product. The market analysis provides tremendous demand. The local and international governmental support sponser the implementation of hydropower worldwide. Hydropower could therefore be the route of success - both business success and personal success !

First of all we have to learn about possible competition and available local expertise and capabilities. The belief to be better must be transferred in modest politeness. The understanding of local tradition and the acceptance of the cultural and economical background must guide you for success.

The next approach is communication with the local experts and a sound knowledge about the existing systems. Studying the hydropower will teach the expatriate expert and guide his own expertise to be enhanced on the existing. Once you are aware about the availabilty and the demand, you will be able to realise projects in a higher quality than others.

Once you have upgraded yourself about the country of your business interest, you recognise the advantage to be an expatriate international expert. You will feel the preference and trust that result from your respect to the new born clients.

We express our conclusion No. 2 that being a little bit superior than you competitors makes the entry In a foreign country smooth and more acceptable.

Oops - we did it again

Dr. Hutarew & Partner is a small consultancy company with enthusiastic expertise in hydropower.

The companys philosophy to provide the full range of expertise in a package has been successful in Europe and started to be transferred in 1993 from our station in Dubai to India. The relation between the general manager of close business friend in Dubai introduced ourselves to the Indian business world. Best understanding between a locally competent partner, who understands the mentality of origin and destination - in our case German and Indian culture became the foundation for a trustful upgradation of myself. Travelling to India in the company of a local expertised partner helped to communicate and adapt the local scenario. It took two and a half years until we started our first projects for the big industries in Gujarat and provided services in the environmental sector.

Contact with local authorities, institutes and industries started to grow. We could feel how delightfully the Indian partners accepted our expertise to help them out.

The relation to people and the personal appreciation developed our reputation of being sound and reliable expatriate business house, but still trust was not there that the "Jet set consultant" would leave and leave back unfinished the required work.

We did the opposite. I admit that we had the luck to meet a local expert, who was not only excellent educated but as well capable to understand the transition between local and international standards. A personal relation and trusts of travelling together through India on project investigation as local advisor led to the setup of an India based international company in New Delhi. In 1997 we started a modest office with steadily growing staff and latest engineering tools. The communication between the European based head office and the local office works perfectly through e-mail and backstopping on demand. Quality control is implemented by company's rules and accepted and handled by the local staff in both offices.

Contacts with finance institutes and cooperation with all leading manufacturers lead to best performance for our clients. We advise and commit in BOT, EPC or other financial setups as well.

All these efforts do not substitute the necessity of the European Experts and myself to give the comfort of closeness by travelling to India. This comfort and the growing appreciation for the Indian culture and better knowledge of the mentality have been one of the major aspects of leading us to our modest success.

My conclusion No.3 is thereafter: Consider your clients as partners.

Conclusions

In our small hydro world we are able to eliminate some major misunderstandings between international and locally grown expertise. Manpower is one of the secrets in India and tough competition in education is one of the secrets of the future growing success. We avoided not to substitute manpower by communication tools and automative equipments. Operating turbines can be implemented like in Europe for unmanned and remote supervision to increase reliability of the units. Manpower for screening support, maintenance and auxiliary support can be provided but must be extremely well trained.

Trust in new technologies can be built up by transfer of knowledge and understanding.

The major reason for refusal of success comes not only from electricity companies and difficult governmental procedures but also by mistrust of international funding institutions as well. We have finalised the designs for hydropower in the North of India since two years but still grid evacuation and power purchase agreements are hindering the setup.

We have learnt from past the worldwide conflict (deregulation) between the state electricity boards and private investment in energy resourcing. Their destiny was to fail everywhere, but in the process the infrastructural development of energy supplies got delayed. My last recommendation No. 4 would therefore be - let the government and their organisations learn from our mistakes in the past - permit the so called developed countries to perform and you will be able to help the people and the industries.

For us the development will continue; our reputation hopefully as well. Acceptance will grow and my staff members and myself will become accepted members of the international hydro community, half German and half Indian. I believe in this being recommendable path for success.

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Solar Thermal Power Plants- A Clean Electricity Option for Agglomerations

Joachim Benemann

Abstract

Between 1984 and 1991, nine solar thermal power plants with a total capacity of 354 MWe have been installed in California. In the period between 1991 and 1996 there seemed to be a standstill with respect to further projects. But in the last years' discussions on environmental pollution, attractive financing instruments and an increasing demand on electricity in developing countries (often located in geographical areas with high insolation) have created new interest in solar thermal power plants. As a new application for solar cells, the integration of photovoltaics into buildings was developed. The use of photovoltaics in residential homes and public/commercial buildings has created a new market for this technology.

Solar thermal power generation

During July 1997 five 30 MWe solar electric generation power stations, located in the Mojave Desert in California, USA, have set a new performance record. The solar-to-electric efficiency of the plant was 18% on an average and exceeded 20% between 9:00 a.m. and 5:00 p.m. on July 1st this year. The electrical output of the five plants reached 2,100 MWe/h per day.

The plants were erected between 1984 and 1987 by the American company LUZ which went out of business in 1991. The glass reflector trough system, the key component of the solar plant, has been supplied by the PILKINGTON Group and manufactured in Germany. Since 1991, when the two last 80 MWe solar thermal power plants were completed in California, no new plant has been constructed. The worldwide electricity demand is expected to grow by approximately 70% over the next 15 years, caused mainly by population growth and the rapid industrialization of the developing countries. Solar thermal power technology could have the challenge to be the most successful type of solar technology, suitable for most of these rapid growing geographical regions - that means countries with fast growing industrialization are very often located in the sunbelt of the earth with high annual direct solar radiation.

Solar thermal concepts for bulk power generation

Five distinctively different solar thermal electric conversion concepts are available, each with a different level of operating and commercial experience. Of these, parabolic trough and power towers are the most prominent. There are, in addition, two non-concentrating technologies: solar chimney and solar pond. Because of its R&D-status I do not want to make any further comment now. Also parabolic dish systems which are anticipated to have high development potentials and which could be ideally suitable for lower power classes from a few kW to a few MWe and particularly for remote power supplies will not be discussed with respect to the present focus on bulk power. Two main solar thermal concepts for bulk power production have been developed and will be described in more details:

Parabolic trough systems

The parabolic trough or solar farm consists of long parallel rows of identical concentrator modules, typically using trough-shaped glass mirrors. Tracking the sun from East to West by rotation on one axis, the trough collector concentrates the direct solar radiation onto an absorber pipe located along its focal line. A heat transfer medium, typically oil, at temperatures up to 400C, is circulating through the pipes. The hot oil converts water to steam driving the steam turbine generator of a conventional power block.

Solar power tower

The solar central receiver or power tower is surrounded by a large array of two-axis tracking mirrors, termed heliostats, reflecting di-

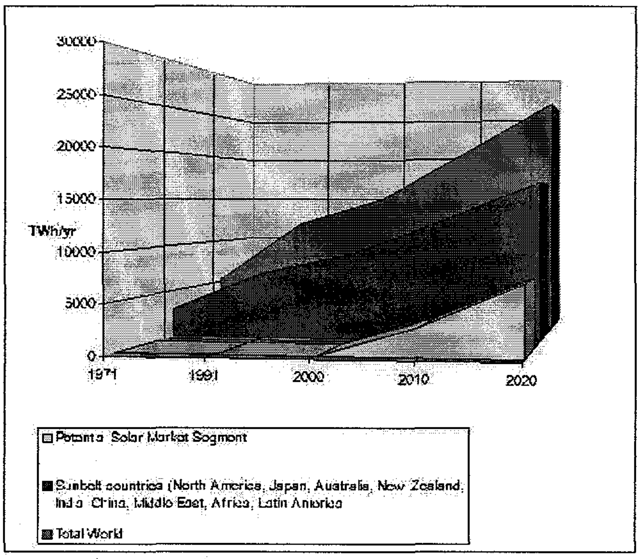


Figure 1: World electricity demand, evolution and potential contribution

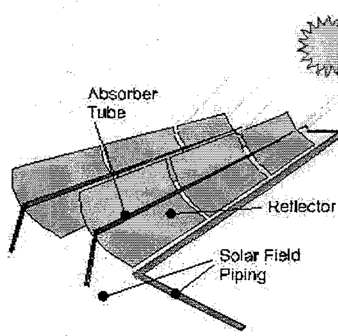


Figure 2: Principle of trough

rect solar radiation onto a fixed receiver located on top of the tower. Within the receiver, a fluid - water, air, liquid metal or molten salt have been tested - transfers the absorbed solar heat to the power block where it is used to heat a steam generator.

Up to now the only commercially operated solar thermal power plants are based on parabolic trough technology. A comparison of parabolic trough and central receiver systems are given in table 1.

Economics of solar thermal power production

Solar thermal power plants are basically conventional thermal power plants with a dual fuel source: converting water into steam for the conventional steam turbine generator through concentrated radiation energy from the solar field and burning fossil fuels in the boiler. This integration of an intermittent solar resource into a conventional power generation system is the solar thermal power system's conceptual advantage. Although "solar fuel" is free, the solar field of a solar plant represents nearly 50% of the total plant's investment cost. However, the investment dollars spent today actually prevents future fossil fuel from being burnt, thereby saving fuel expenses. In the early 1980's, when fuel prices were 50% higher than they are today, solar thermal power was a very attractive option. The technology, however, was then not fully developed. This scenario in the 1980's was

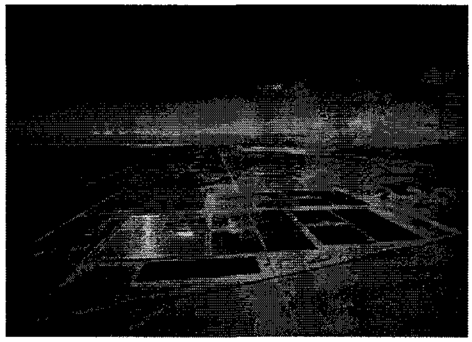


Figure 3: Parabolic trough power plant at Kramer Junction Company, California, USA

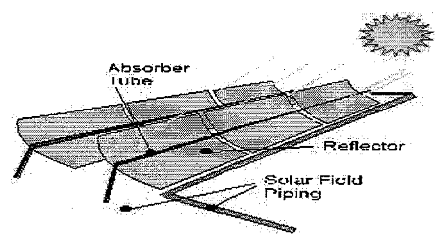


Figure 4: Power tower test unit in Barstow, California, USA

the logic for the commercial start of solar thermal power plants in California. Today, prices of around $ 20 per barrel of crude oil offer no full compensation for power producers to invest in a solar field.

Solar trough cost degression

Due to over-capacities, technical advances of conventional power plant equipment and market pressures from low-tariff schemes offered to independent power producers, prices have been cut down for conventional power plants. This market situation led to the recent tendency to only finance larger unit sizes

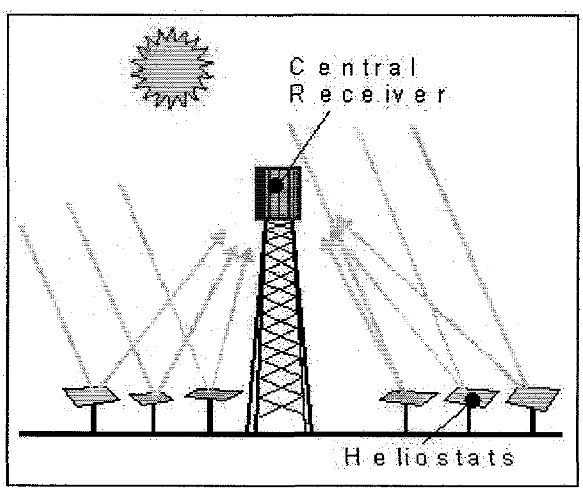


Figure 5: Tower principle

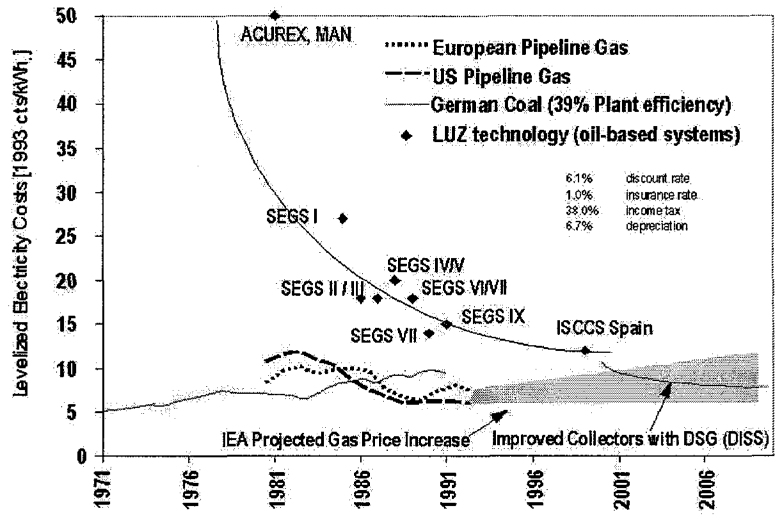


Figure 6: Energy Costs

for base-load fossil power plants. The solar thermal parabolic trough power plant industry reacted to these market forces by integrating solar fields into gas-fired combined cycle plants. These project developments indicate that such integrated solar combined cycle systems are able to offer a competitive base-load electricity cost of 5 - 7 cts/kW·h at solar shares of 15 - 25%. By studying the economics of power tower systems such as the air-cooled 30 MWe plant called PHOEBUS proposed by a German industrial company and initially designed for Jordan, it is expected to be able to produce power at about US 12 cts/kW·h with a solar share of 50%. Further cost reductions are anticipated for power towers in the 100 - 200 MWe class. Respective test facilities such as the 10 MWe SOLAR TWO located in California are in operation to confirm the estimated cost reduction potential.

The sunbelt - A difficult power market for solar electricity

It is estimated that between 1991 and 2010 approximately 900 GW of new thermal power plant capacity additions will be needed in the sunbelt, excluding capacity replacements and hydro projects. This region, with environments which are the most meteorologically suitable for solar thermal power plants can supply, in principle, more than 400 GW of this market with solar power. Again, this means nearly half of the new thermal power plant capacities needed in the sunbelt in the next 15 years can be, in principle, supplied by solar thermal power stations. Considering that since 1991 no solar power plant has been installed, the environment for a successful implementation of large scale solar thermal power plants has changed significantly during the last years. Two developments could be observed whose impacts are somehow reverse: On the one hand, investment costs for conventional fossil fueled power stations have been cut down dramatically due to heavy competition and liberalization in the power sector. On the other hand, attractive financing instruments have been created in order to balance the investment cost gap between solar thermal and conventional power plants. The most prominent of these new financial instruments is the Global Environment Facility (GEF) administered jointly by UNDP and the World Bank which offers additional financing. Also the World Bank's solar initiative and the European Union's JOULE and THERMIE programs offer additional financing to support the introduction of solar thermal power plants on a larger scale to tackle the greenhouse effect, especially in the developing world where power demand is growing fastest.

In addition, joint implementation has become an innovative financing tool. Joint

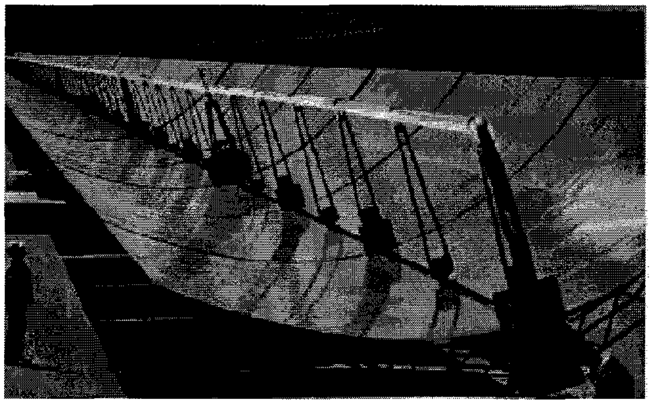
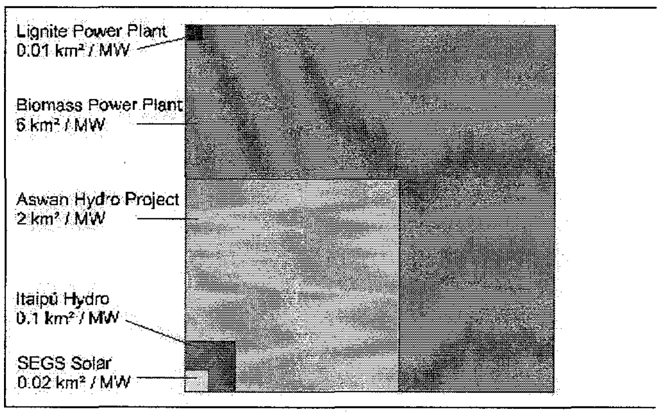


Figure 7: Parabolic mirror



Land use of different renewable technologies

Figure 8: Funds used for RE technologies

implementation, introduced during the Rio follow-up conference in Berlin in 1995, is a new concept of cooperation for climate protection between the industrialized countries and the developing world. Utility companies in OECD countries recognized that investments in further reducing emissions in their own efficient facilities are far less effective than the same investment for rehabilitating plants or constructing new state-of-the-art power plants in the developing nations. If utility companies in industrialized countries are obliged to reduce the emissions from their power plants to a certain level, it would be more cost effective to invest this money in the third world. However, the incentive to invest can only exist if certain emission levels are binding for the utility companies through instruments such as the taxation of emissions, resulting in an expense which can be written off for the reduction of emission levels anywhere in the world by the same utility company. One of the large German utilities, the PREUSSEN ELEKTRA, is now participating in such a joint implementation strategy to get more experience in this field.

Among the seven actual solar thermal project developments, the project on the Island of Crete could be the first one where joint implementation could be demonstrated. The project called THESEUS consists of a nominal 52 MWe net solar power plant with an advanced parabolic trough collector field as the primary heat source. The project site is located on the Southern coast of Western Crete which has one of the highest Eu-

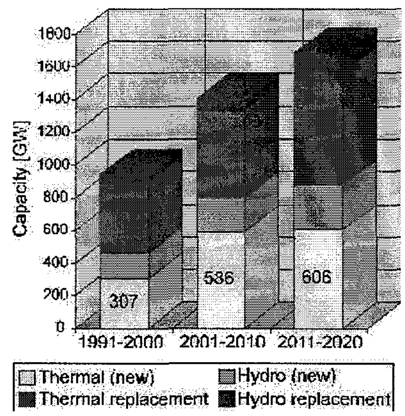


Figure 9: Range of LEC for different power plants by type, size, fuel and utilization

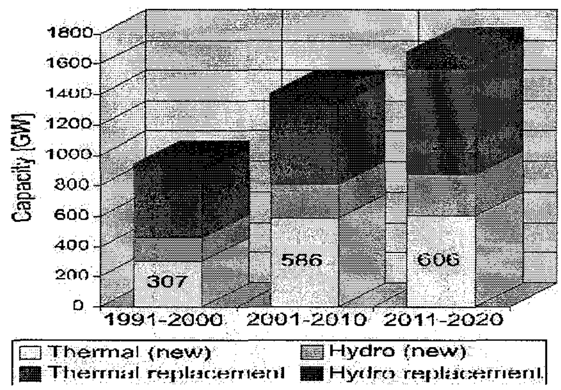


Figure 10: Market capacity of energy production

ropean solar radiation level of approximately 2,300 kW·h/m which is comparable to Sahara Desert site locations. The power block is a conventional rankine cycle re-heat steam turbine. The solar field energy source is supplemented with an oil-fired boiler to supply steam during conditions of low insolation such as cloudy or rainy days. This is important to secure the nominal capacity whenever it is needed. Full turbine output can be achieved in any of the three modes of operation; solar only, oil only and hydrate mode. The solar field will consist of an advanced design based on the LS-3 parabolic trough as used for the latest 80 MWe plants built in California, but improved by a number of innovative features developed over the last five years in California. The plant will generate about 200,000 MW·h and and will be able to produce electricity of about 9.6 US cts/kW·h.

The total project investment will amount to about 150 million USD. The THESEUS project will reduce the Greek energy import bill by about 4,5 million USD per year as the solar field will enable to avoid approximately 27,500 tons of heavy fuel oil per year. Even more important, however, the solar power station will replace about 2,700 day-time peak to mid load hours of costly gas turbine operation whose fuel related power generation costs are as high as 15,2 US cts/kW·h. This day-time peak stems basically from increasingly strong growing tourism. The new solar power plant will not only enable the Cretan power sector to save on the order of 10 million USD per year, but will also avoid approximately 200,000 tons of CO_2 emission per year.

Environmental benefits of solar thermal

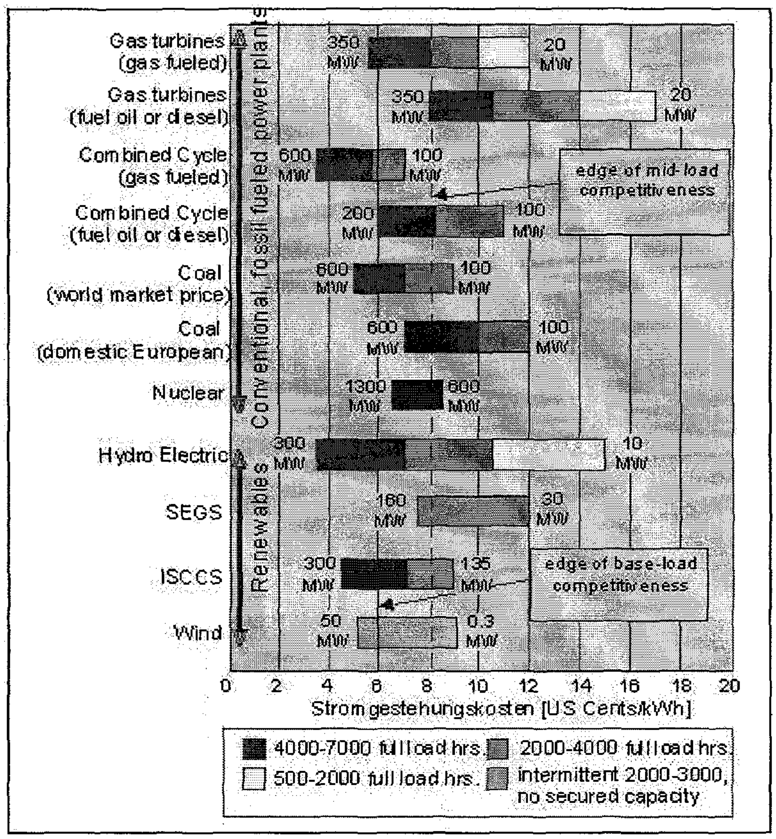


Figure 11: Incremental power plant capacity needs: 1991 - 2020

power generation

One of the most controversial environmental public debates of the last years addressed the effects of energy-related emissions. The largest source, contributing to nearly 50% to the greenhouse effect, can be attributed to energy-related CO_2 emissions.

Solar thermal power plants could reduce the CO_2 emission to almost a third of a Fuel#2 based power plant. We have made calculations which show that an 80 MWe solar trough power plant avoids about 4,7 million tons of CO_2 emissions and could save more than 2 million tons of coal equivalent over its 25-year lifetime. Also, the land demand which was discussed several times and seems to be an important factor shows that solar thermal power plants are extremely acceptable compared with hydro, biomass or lignite based power plants.

Table 1: Parabolic trough and central receiver systems

	Parabolic trough	Power tower
Applications	Grid connected plants Medium-temperature process heat	Grid-connected plants High-temperature process heat
Experience	Commercial with 9 SEGS plants built 14, 30 and 80 MWe units Total of 354 MWe installed 7200 GWh fed into grid Solar field availability constantly exceeds 98%	Several test and demo units. Largest: Solar TWO: 10 MWe
Commercial status	Continuous operation since 1984, accumulated revenues of more than US$ 900 million	Turn-key offers have been announced by manufacturers
Advantages	Commercially available Solar-fossil/hybrid concept proven Storage capability Integration in combined cycle designed Further cost reduction potential anticipated	Good long-term perspective for high conversion efficiencies and storage at high temperatures Significant further cost reduction potential anticipated Solar-fossil/hybrid operation possible Integration into combined cycles possible
Disadvantages	Lower temperatures restrict output to moderate steam qualities due to temperature limits of oil	Capital cost projections not yet proven Operating projections and system reliability not yet proven Promising salt receiver not yet proven

Country	**Capacity (MWe)**	**Plant type**
Greece (Crete)	50	Rankine Cycle (SEGS[1] California)
Egypt	100	Rankine Cycle (SEGS California)
India (Rajhasthan)	200	Combined Cycle (ISCCS[2])
Iran	> 200	Combined Cycle (ISCCS)
Jordan	30 or 100	Tower or SEGS
Mexico	312	Combined Cycle (ISCCS)
Morocco	55 or 150	SEGS retrofit for coal power station or ISCCS
Namibia	150 or 300	SEGS or ISCCS

Table 2: Solar Thermal Parabolic Trough Power Plants Actual Project Developments

The solar thermal vision

A possible market success of solar thermal power plants will heavily depend on the choices made between environmental protection and the lowest possible electricity generation cost. As these are in many ways mutually exclusive, the final outcome will depend on both energy policy decisions and international support for responsible environmental actions in a climate of scarce financial resources. The message we are able to give is clear:

- solar thermal power plants are technically fully developed;
- parabolic trough plants are commercially proven;
- solar thermal power is politically desirable and is close to being nearly competitive;
- the use of solar thermal power can reduce emissions on a global scale.

The crucial steps for solar thermal projects include the establishment of adequate compensation rates for clean electricity which creates appropriate incentives from financing organizations and governments to make solar thermal power competitive and to include solar thermal power generation into a general environmental protecting strategy.

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Wind Energy - Grid-and off-grid Applications in Developing Countries

Aloys Wobben

Introduction

The following presentation will give the background on the world energy situation, then focus on wind turbines, followed by the application of wind energy.

World energy situation

To take a historical perspective: before James Watt was born, humans used biomass almost exclusively. Increasing industrial activity brought increasing consumption of fossil fuel resources. Now, energy reserves are noticeably reducing.

If we do nothing, worldwide energy consumption will continue to increase dramatically, until about 80 years time, when all reserves will be spent. One solution is to start immediately using renewable energies, and dramatically increase their usage each year, as per figure 1 on the next page .

The trend of oil prices over the last five years is very noisy; the market is quite hectic and volatile. It is estimated that in the absence of political influence, it climbed, on average, about 8% per year. In five years, that results in an increase of about 50%.

Wind energy and Enercon

I started with Enercon in 1984. We've installed a total of 1.9 GW of generating capacity to date. We employ 2500 people directly, and had a turnover in 1999 of 865 million DM. Our production floor encompasses 130.000 m^2. We export to nineteen countries.

According to the necessary projected increases in use of renewable energy resources, our target is to produce large volumes of material. We started by only doing R&D, and making prototypes. We originally made wind turbines with gearboxes, then moved away from them when we found better solutions. At this point, we could produce large quantities. We've developed specialty areas as well, in blade and generator production.

Our export activities started in Europe, then expanded to India and South America. We are hoping to expand further, and bring wind energy to other parts of the world.

Developments at Enercon

There remain many issues for R&D. A large group and Enercon is electrical and electronic engineering. For example, a large wind turbine with a 1,8 MW capacity has 24 microprocessors on board – it is a very complex machine. It's more or less a robot with a job to produce kW·h. Plans for unusual situations have to be made, such as shutting down in the event of lightning strike, and being able to start again three minutes later.

The mechanical parts, such as towers and other components, involve very detailed finite element calculations, which include performance predictions over a twenty year lifecycle. Twenty years might sound short, particularly when compared to a human life span. However, we have to cut out fingernails from time to time; we reconstruct regularly. Wind turbines, however, must simply be designed very well the first time.

The need for reliability

As mentioned earlier, gearboxes were not a good solution with wind turbines. A wind turbine without a gearbox does as many revolu-

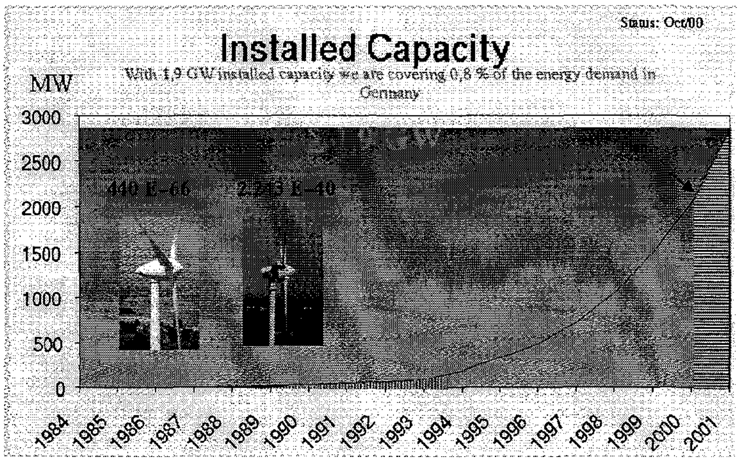

Figure 1: Energy for the World

tions in ten years as a standard wind turbine does in thirty days. The stress on a gearbox is tremendously high; it's better not to have a gearbox.

Components like bearings are also a problem when designing machines which must last 20 years. All bearings have a maximum load, and they also have a minimum load, which is much harder to define. The bearing must only operate between the maximum and minimum load. Taking our example of 1,8 MW bearing; it should be operating in twenty years, and possibly even for thirty years. However, if the speed increases to 1.500 rpm, there is no chance it will survive its full working life.

Quality is very important for wind turbines. The flange for the tower, for example, is bolted in place with a pre-stressed bolt. If there is a load on the tower, the pre-stressing is reduced. The pre-stressing is not dropped to zero, but it is reduced. This way, the bolt always has stress from only one direction. If the machine flange is badly machined, the screw must deform the flange. This is a strain on the bolt before any load from wind appears. To produce a good car is easy by comparison, because the working hours of a car are so much lower than a "simple" flange.

Power storage

Storage systems are another focus; how to store energy so energy can still be delivered when there is no wind. The autonomous grid is a complex thing, but it's where we must work. A niche market solution is a high-efficiency solar inverter.

Power consumption in Germany doesn't tend to fluctuate badly throughout the year, but it is apparent that power consumption is much less at night than during the day. During the day, there are also peak periods. Renewable energy faces a large challenge in dealing with this. It's also worth noting that in many places, such as small islands, the swing from night to day is much stronger, and the peaks can be more pronounced.

To deal with this problem, we're working on storage systems incorporating batteries and flywheels. We've found that an important area of R&D focus is improving battery life. The flywheel is important for power peaks or for grid stabilization. This can be augmented using a diesel drive, connected to a synchronous machine to give better power quality. We're very happy with the flywheels we've produced. They're not built for 20.000 rpm service; they're built for a long life of service, and they're not the hazards some of their high-speed counterparts are reputed to be. For fifteen years, I worked on designs for 20.000 rpm flywheels, but they were essentially dangerous.

The solar inverters we've installed are another side project. They have a capacity of up to 840 kW. These inverters were specially designed for high efficiency with solar applications. As an example, we've installed a 300 kW wind turbine with a solar plant, on an island.

Desalination

A new technology for us is desalination. There is a good market for it; there is certainly a need for good drinking water. A combination of wind energy and desalination is a wonderful thing.

We have set up such a system on the island of Syros, in Greece. A new feature of this plant is the fact that we need 30% less power than a standard system of equal production. We have done a similar, but smaller, desalination system on Teneriffe. We like to maintain experience with different sized systems.

Conclusion: Enercon at home and abroad

Our partnerships in India and Brazil are working well. We continually bring people from the daughter companies to Germany for technical and professional exchanges.

One project in Germany, in Hanover, near the expo site, is a small farm site, consisting of livestock such as cows, pigs, and sheep, a small cheese factory, and farmhouses all powered by different power supplies. The power supplies include wind turbines, solar PV, and biogas. There is a small local water treatment plant, and a block-type terminal power station. The setup is fairly complex. The community is served with electricity, heat, and cooling from these renewable energy sources. For us, this has been an excellent learning experience on handling different energy sources.

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Energy from Biomass - New Applications in Developing Countries

Hartlieb Euler

Introduction

Biomass technology is such a wide field that we have to focus on, concentrate, and select one of the parts.

The portion we've selected is the anaerobic process. However, even among these processes, we have to just take a small selection. Just to get an overview of some of the processes, we have combustion, gasification, charcoal making, biodiesel, anaerobic processes, and production of biomass.

Overview of biomass based production

In principle you organize the processes into primary energy production, which is a process in which you invest energy into the production of biomass to make energy from it. As one example, I was just visiting a very interesting production site in Brazil, where they produce some 3000 km^2 of eucalyptus and make charcoal for national steel production. Another primary energy carrier is grass production, which start to be used in some large farms in Germany now for anaerobic digestion now.

All the other processes are based on secondary biomass, which is waste biomass from animals, humans, and plants. Most important, of course, is direct combustion and charcoal making for household energy purposes. Some 2 billion people depend on that, and those programs that try to improve efficiency on that type of energy are the most important; they're the most broadly based with a big impact. The German Global Development Co-oporation is doing important research and development activity in this field, in a number of countries.

Biodiesel and gasification are fairly stagnant at the moment – there's only slow progress to be reported on. I'm going to concentrate on anaerobic processes which aren't very well known.

Introduction to anaerobic digestion

Most of you who know something about anaerobic processes. Normally, it's small agricultural biogas plants which are being discussed. In other sectors it is rather municipal sludge plant.

This is a discussion on the majority of applications. Basically, you have wastewater, you have sludges, and you have solid wastes which can be treated anaerobicly. They derive either from agriculture, industry, or municipalities.

Different technologies exist for different industries. If you look at the industrial portion, you see there is another variety of about twenty to thirty applications, if you think of the different industries. This shows how many different technologies are available on the market, and sometimes need to be developed.

There are at least nine common, distinct technologies. If you look at the industrial applications, you can multiply it by twenty – the number of significant, different industries requiring anaerobic methods. You have very different sizes of course – you have applications with a cubic meter size, or five cubic meters, up to five to ten thousand cubic meter industrial plants.The range of investment is equally large, from $200 for a small unit in Sri Lanka up to $200 million for a very large plant now being built in Spain. The range is 1:100 000, even 1:1 000 000 in terms of sizing and cost, so sometimes the discussion about anaerobic technology is very confusing, because people are often talking about different issues.

You have a differentiation as well between northern countries and southern countries. Anaerobic decomposition, as most of you know, is just the decomposition of organic material without air. This is much easier when it's warm – the bacteria like it warm. The southern countries are more suitable for anaerobic digestion, even though at the moment the technology moves a little faster in the northern countries.

Among the nine different applications which are possible, and where exist different technologies, there is an option to combine some of these technologies. It's called co-fermentation, where you typically use either wastewater sludge and solid waste together or industrial, municipal, and agricultural waste together. This is another type of technology which needs to be discussed and looked at.

There are different objectives and different countries, in term of budget, and in terms of natural conditions. As such, there is a wide range of anaerobic technologies, which exist. We have to be very careful when discussing biogas or anaerobic technologies and be very specific and precise about what we're talking about.

Energy production

To give you a little idea about the different objectives which exist for the application of the technology, we've focused mainly on energy. The focus doesn't really need to be on energy; often it's in completely different areas.

The production of renewable energy is for the transformation into electricity, or heat and cold storage, which isn't broadly applied yet. It's also for direct gas use, in which you are saving process energy – a very important parameter. For example, most of the sewage treatment plants in southern countries which stop operation, this is not for technical reasons or because of a lack of trained people, but simply because the electricity bill hasn't been paid. Large aerobic sewage plants have a very large energy input, and often the municipalities aren't willing to pay for it over the long term.

There is also a very large portion of positive climatic effect. It's not only a production of renewable energy and reduction of CO_2; 50% of the effect on average is a reduction of wild methane emissions. If you have a pond of industrial wastewater, there are huge emissions of methane over a 10-year range. Methane has an effect 52 times higher on the climate than CO_2. In discussions of climate and methane, wild methane emissions are often not emphasized the way they should be. Anaerobic digestion technologies can cover both reduction of CO_2 with the use of renewable energy, and the reduction of wild methane emissions.

Solid waste treatment stabilization and separation.

This isn't a widely applied process outside Germany – Germany has about 100 plants of this type. This is not the landfill capturing of gas – it's biogas plants process that use and digest solid waste. Either the biological portion from separated waste, or the full share of the waste can be treated anaerobicly. There is a huge amount of gas that comes out and is used for electricity production. In Germany, all the major cities have such plants. Outside Germany, there are one or two plants each in Denmark, Holland, and Sweden. Within the southern countries, this modern technology is barely applied as yet.

Of course, the energy portion is important, as it's producing energy, not using energy. The same applies for wastewater treatment and water resource protection. Wastewater treatment has an energy requirement. If you treat the wastewater anaerobicly, you can produce energy while if you treat it aerobicly you consume a lot of process energy.

There are two different processes between southern and northern countries: in southern countries you can treat sludge and wastewater jointly, mostly in UASB plants, and in European countries you can only treat the sludge, because the wastewater is too cold. In European countries, sludge reactors are used within activated sludge systems.

Soil improvement and the production of compost and fertilizers

Fertilizer production has a huge energy requirement which needs to be calculated into the overall assessment. There are other benefits to using anaerobic technologies to produce fertilizers, like hygiene and smell. Reduction of space is another advantage, which is often crucial – you need no room for landfills or wastewater ponds. Sludge reduction is another factor - according to World Bank calculations, 50% of municipal wastewater treatment costs are sludge disposal costs. If you use anaerobic treatment for wastewater, you reduce the sludge considerably.

Another particularly important point for the south is the reduction of deforestation. Anaerobic plants can provide household energy, and reduce impoverishment of soils, preventing desertification.

Focusing on more details of the operations, we have the following.

Industrial wastewater

A general application for large-scale is industrial wastewater, which has a fairly long tradition in southern and northern countries, but only for large industries which can afford them – these plants are normally quite expensive. As such, you only tend to see them used by the large companies, like coca-cola, breweries like Heineken, and so on. You'll find them in Nigeria, Vietnam, Germany, and Holland. The drawbacks in this area are

- cost reductions for small to medium applications aren't there.
- specifications for different kinds of wastewater are lacking.
- investment into smaller plants is not yet sufficient.

Agricultural sludge

Another widely-known general application is agricultural sludge. It is quite commonly used in southern countries, quite often in China and India. It's also used in northern countries, in the form of agricultural biogas plants. For example, in Germany we are currently moving quickly into further dissemination of that technology, mainly based on a feeding price – the feeding price has been increased in Germany to 8 or 9 cents at the moment. Also, the slurry from agricultural farms must be stored – it can't be applied to the land at any time, so you need a storage that changes the cost relation. There is a big move in Germany toward agricultural biogas plants, but of course the larger share is in other countries.

What is interesting here is that wastewater can only be mixed with municipal wastewater in the southern countries – this is a technology which doesn't exist in the north due to the temperatures which only exist in the south. This is a major hindrance to the technology of anaerobic treatment of municipal wastewater, because all the technology exporters and financing companies don't know much about that technology. They continue to apply aerated systems which are about twice as expensive. This is a big mistake, as it is too expensive. Southern companies need to concentrate on this approach, even though experience is not very broad yet.

Another approach where you only have application only in few countries is anerobic solid waste treatment. This has only been applied in Germany so far.

The dimension of applications we all know – India and China have very strong applications in the agricultural sector. China has applications numbering in the millions, India in the hundreds of thousands.

There are typical solid-waste treatment plants, serving about 50 000 people or more, operating in Germany now. They're integrated into a natural setting, in an area where you don't have to worry – there are no neighbors close by. The insides are clean, and don't smell, as everything inside is housed. Production for a unit serving 50 000 people is about 2 000 000 kW·h.

Let me give you one reason why solid waste treatment is interesting when you use an anaerobic process. Most of the substances, which we want to treat are more suitable for anaerobic treatment because they are wet. If you look into the overall mass which occurs to be disposed of, 99.9% are water and organic biomass. Our concentration on biomass is much too limited. If you concentrate on that portion, if we talk about disposal and distribute our costs, we could save money if we focus and put wastewater, sludges and solid waste into a joint disposal and treatment approach.

I want to give you one example why it is important to look into organic waste. That is an example in Brazil, where they take all the municipal and industrial solid waste together, separate it by hand, and make compost out of it. This happens even in a country where you have a lot of land, where organic is not very important, and where even the energy portion isn't so important.

To give you an idea of potential, there is a potential to generate 1 500 MW in Brazil, for example. In Germany the figure is 750 MW. Altogether, worldwide, we reach a total of something like 75 000 MW. The world-wide energy potential from anaerobic waste digestion , not using primary biomass, would be in the vicinity of 1 000 000 MW installed. So far, we have much less than 1% of that. If you look at solid waste treatment costs, you see there is a considerable potential for anaerobic digestion. The costs have been reduced, because in Germany aerobic digestion systems have to be housed. Because of this, the costs of aerobic digestion have gone up – it's a competitive technology.

The main difference in how anaerobic wastewater sludge works in developing countries is that it is distributed from the bottom and treated by a bacterial bed. The main differences are that you have to put in aeration (about 100 kW), and you get a loss of heat from the aerobic system. You get about 30 to 60 kg sludge from an aerobic system. From an anaerobic system, you get 10 to 12 kg CSB. You get a lower decomposition, but you only get 5 kg sludge. You produce 285 kW·h and you don't need to put any energy in, which makes a huge difference.

These calculations were made on a very conservative basis. We have surveyed 200 plants in 16 countries worldwide, and compared activated sludge systems with anaerobic treatment systems on a same-decomposition basis. We came to the result that in investment cost and operational costs, anaerobic treatment reaches less than 50% of the overall cost.

I want to describe one more example for innovative industrial wastewater treatment – it's a UASP (called InWaSia, which we have developed and built 2 prototypes) for smaller applications which can be standardized and put into a container. It has plastic components, and swims on the surface - you can put it into a pond instead of a concrete construction. This reduces costs by about 50%.

Another example is an integrated co-fermentation we have built, with industrial, solid waste, and agricultural waste. It's something which is on the move in Germany at present. This reduces costs by integrating heat and electricity production.

Another example is an apartment building where wastewater and solid waste treatment are being applied in the bottom.

The main conclusions are

- present applications are not widely known. There is much broader application yet in the sector.
- advantages include reduced energy consumption and increased energy yields.
- other advantages are environmental protection, health, hygiene,
- makes it possible to reduce costs, increase exports and employment.

What is most important is an intersectorial approach – we can't just calculate anaerobic technologies on an energy basis alone. We need to include wastewater, soil, and hygiene, climatic effects. We need to move the political framework in this direction, and set examples in some countries.

There are some very big programs running at the moment in Nepal. The KFW is doing a big program in India. UNDP is doing a farily big program. US aid is now in Jordan, ADB in China looking into the sector. The World Bank is doing things in Latin America, with the IDP. But technical and management instruments are not sufficiently applied yet. We have to look into the financial way these technologies can be financed to integrate the external costs into that technology. That's one of the best way to get an increased application organised; in Germany at the moment, it's moving due to an increase in energy prices. We need to factor in environmental costs through political measures, legislation, political pressure, sensitization, and education.

Thank you.

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Session III

Financing

Financing Renewable Energies - An Introduction

Michael Stöhr

Different kinds of investments requiring different approaches to financing

Three types of investments

New investments in renewable energies in developing countries vary widely in nature, potential investors, and required capital. One needs therefore to have a closer look on the kind of investment and to develop specific adapted financing solutions for each type of investment situation. In this paper three types of investments are distinguished (see Table 1):

1. large infrastructure investments,
2. community investments, and
3. small private investments.

Specific situation of rural community and small private investors

While existing financing mechanisms are specialised on the first type of investments, the second and the third type are the most important ones to deal with in the renewable energy sector, because renewable energy technologies are usually applied decentrally and system and investment sizes are small compared to usual investment volumes. Though decentral application of renewable energies is usually the most cost-effective solution of energy supply in rural off-grid areas, this fact implies a number of barriers to financing for the majority of renewable energy investments, like the inexistance of financing institutions in rural areas or the too small size of required finance. The example sectors from which lessons can be drawn for developing solutions for financing small and medium size renewable energy investments are notably the agricultural and the housing sector.

Large infrastructure investments

Large infrastructure investments in renewable energies in developing countries are notably hydropower stations, but also increasingly wind parks. Such power stations need electric grids - which themselves represent large investments - to transport the generated electricity to the consumers. Investments in fuel storage and transport infrastructure belong also to this category, but are not yet made for renewable energies, but still for fossil petrol products and natural gas.

A well known financing situation

The investors in large energy infrastructure are generally large, very often state-owned companies and the investment sums are in the range of several hundred thousand to several hundred million EURO. Financing of large infrastructure investments in renewable energy use is therefore similar to financing of any kind of industrial or public infrastructure and well established financing mechanisms exist. The problems which are to be solved are individual ones and not of generic nature, i.e. issues such as the liability of the investor, securities, etc. need to be solved, but in principle schemes for financing exist and need just to be applied. The situation is different at this point for community and small private investments, notably in rural areas of developing countries.

Community investments

The main energy source: wood

When talking about financing of renewable energy technologies in developing countries, one has to keep in mind that some 90% of the energy needs of many developing countries are for cooking food and are met by fuel wood. Generally fuel wood, a renewable energy source, but in many cases not used in a sustainable manner, is collected without that the users pay for it and thus stays out of the flows and statistics of modern economy.

However, financing becomes an issue to be taken care of for these 90% of the energy consumption when one investigates mechanisms that preserve the forest ressources and make fuel wood use more sustainable. The investor in this case is usually a village community or some structure at village level like a cooperative or some traditional social organisation.

The example of the Sahel region

An example region where the whole range of issues concerning fuel wood supply can be observed is the Sahel region in West Africa, well known for its dramatic drought in the 1970s. As in many other developing countries, the energy sector in the Sahel region is characterized by the dominance of domestic energy consumption for cooking and the use of biomass such as wood, charcoal, dung and agricultural residues for meeting the domestic energy needs. Wood is actually not used in a sustainable way and deforestation is dramatic, thus putting into danger not only the continuity of energy supply, but the ecological balance of the region as a whole. The energy consumption of the Sahelian countries is strongly increasing, essentially because of the strongly increasing population.

The stronger environmental impact of urban wood consumption

The Sahelian fuel wood and other biomass consumption patterns differ strongly between urban and rural areas: while in rural areas essentially deadwood and agricultural residues are used for cooking and other domestic heating requirements, the consumption in urban areas is characterized by a large proportion of charcoal and wood from live trees. The wood for direct use or charcoal production for urban areas is cut in forests around, and sometimes far away from the main cities, thus leading to a strong depletion of the forest resources, especially along roads. Since for the production of 1kg charcoal 2kg wood is needed, the relative wood consumption of urban areas is much higher than in rural areas. All this together leads both quantitatively and qualitatively to a much more negative impact on the environment caused by urban areas than by rural areas. Hence, the need for a transition from the actual use of biomass to a new fuel supply situation is more urgent in urban than in rural areas.

A successful development model: forest management by local communities

In the past the forest resource has generally been managed at the national level in the Sahelian countries. This has led to a lack of efficiency and consequently projects have been executed where the responsibility for forest management was transmitted to the local level, thus inducing a sense of responsibility of the local population and income generation possibilities via the sale of wood. Such projects included successful tree plantations (e.g. a project on 100,000ha in Burkina-Faso supplies now 10-15% of the fuel wood for the capital city Ouagadougou).

The role of local intermediates

The local management of forest ressources is an income creating activity. Its implementation requires the establishment of local community structures which deal with financing issues. These local structures can now play a decisive role in financing other investments in renewable energies, either for the community or for private persons. In Burkina-Faso for instance the income generated by local forest management and sales of fuel wood has been use to finance photovoltaic installations for drinking water pumping and basic electrification.

More generally speaking, it can be said that intermediate structures at village or village cluster level can serve as interlocutor for financing institutions which are themselves not present in the rural areas and can play a decisive role in financing renewable energy investments. The main vocation of such intermediate structures does not need to be the establishment of renewable energy systems. Structures which can fulfill the function of financial intermediates are for instance agricultural cooperatives or housing associations. The organisational form can be both traditional or modern.

Investments in modern renewable energy systems

The same financing issues and potential solutions exist for renewable energy community systems like e.g. photovoltaic drinking water pumps. Since such modern renewable energy systems require intermediate structures also for installation, maintenance, repair, etc. further options for financing solutions can be found by putting such tasks and financing in one hand. Such a solution are for instance energy service companies in rural areas which own and rent/ lease renewable energy systems.

Small private investments

A field similar to agriculture and housing

A very specific, but the most important field of renewable energy financing in developing countries is micro-financing of small renewable energy systems for rural areas such as photovoltaic solar home systems, wind pumps, wind generators, biogas reactors, solar cookers or fuel saving cooking stoves. The issues encountered in this field are specific to small investments in rural areas. They are only specific to developing countries as far as many people in developing countries live in rural areas. The problems of and the possible solutions for micro-financing of renewable energy systems are similar to those existing in the field of agriculture or housing.

Decentralised renewable energy: often the least-cost option

A remarkable fact is that small renewable energy generators like solar home systems or wind generators are very often the least-cost option to meet the electricity needs in rural areas. This is opposed to the general impression that renewable energy devices, notably photovoltaic generators are expensive. The reason for this apparent contradiction is, that many rural areas are not reached by the electric grid - and grid extension is more expensive than renewable energy generators.

The real cost of the elctric grid

When considering electrification in off-grid areas, one can make a simple first order cost comparision of costs by balancing the investment costs of a grid extension against the investment costs of an RE installation. A good thumb rule, which is valid accross the world, states that on average the costs for extending the electric grid by 1 km are approximately equivalent for the costs of a 1 kWp PV installation. (An installation with a power of 1 kWp provides about 1 kW at full sunshine.) PV installations are taken as a reference here though they still represent the most expensive form of renewable electricity generation. They can, however, provide electricity across a very wide power range and are thus best suited for a large number of household in actual off-grid areas. The mentionned thumb rule works well for small, e.g. 50 Wp, installations as well as for multi-kWp installations!

The striking result is that for almost all actual off-grid areas in the world even the still expensive PV systems can provide electricity in a cheaper way than an electric grid with conventional central power stations can. The reason for this is that the density of the electricity demand in most off-grid areas is very low, i.e. households need only little amounts of electricity and are generally far away from the existing grid and relatively distant from each other.

Costs of grid electricity in rural areas

A more detailed cost evaluation allows for calculating the specific costs of electricity: more than 3 US$/kW·h are the real costs of electricity in most rural areas of the world (in fact off-grid areas are generally rural areas, and many villages and households in rural areas in the world are not connected to an electric grid). However, nowhere electricity fees corresponding to the real costs of electricity in rural areas are charged to the customers, but rather those customers are cross-subsidized by urban customers or directly subsidized by the government. Hence the reason why those areas are still largely non-grid-connected in most developing countries.

PV systems, however, can supply electricity for much less than that: between 0.5 and 1 US$/kW·h (costs for depreciation, finance, maintenance etc. are estimated to be about 1,000 US$/kWp/yr and the system yield is in between 1,000 and 2,000 kW·h/kWp/yr depending on the local climate).

The traditional solutions: kerosene and dry cell batteries

The comparision of grid extension costs and decentral electricity generation from renewable energy sources in incomplete if one does not take those electricity sources into account which are commonly used in non-grid-connected areas: Electricity generation by decentralised diesel generator sets is cost-effective compared to photovoltaic installations if the electricity need is above 2-4 kW·h/day (corresponds to about 400 to 800 Wp for the PV generator power). Electricity supply by batteries which are recharged at the next diesel generator or at the next grid connection point is not cost-effective: it costs about 2 US$/kW·h. Electricity from dry cell batteries, a very widely used form of electricity for powering radios and TV sets costs even 100 US$/kW·h!

Insufficient income versus lacking liquidity

The question is why RE electrification of off-grid areas is actually not going on at a more rapid rate. In fact, the PV systems market in developing countries grows at some 15-20% per year, a dream value for other industries, but still to low compared to the potential market.

One has to see that for a potential owner of a PV system in a developing country the decision to be made is between a PV system and traditional alternatives like kerosene lamps and dry cell batteries, not between a PV system and an extension of the electric grid. Note that even the smallest PV systems (PV lanterns with about 5 Wp PV modul) provide a much better service than the traditional alternatives (e.g. kerosene lamps). However, the first investment in the PV system is high compared to the investment in a kerosene lamp for instance, and if the PV system is bought on a loan basis the repayments must be paid regularily while kerosene purchase might be reduced in the case of periods with lower income.

A detailed investigation provides for the following figures:

- For about 80% of the people in developing countries the comfort of very small-scale electrification (10 Wp per person provided by PV systems) is not accessible since they do not have sufficient income. For them, the present costs of PV systems or the unavailability of sufficiently small RE supply devices is the obstacle.

- About 20% of the people in developing countries have sufficient income to pay for the comfort provided by 10 Wp PV per person by themselves. However, they do generally not have sufficient savings to pay the investment costs of a PV system. For them the lack of access to appropriate small loans is the principle obstacle.

The potential role of utilities

It should be noted that the situation where the electricity consumer is also the owner of the electricity generation system is quite the inverse of what is the case in grid-connected areas: there the electricity generation and distribution systems belong to utilities. This implies that the electricity consumer who is served by a utility does not need to make prior investments in electricity generation devices nor to bother about any loan related to such investments!

For utilities however, it is much easier to make investments and they are much more bankable than a private person. For them financing PV systems is generally not a problem, but a number of other obstacles than for the individual owner-user exist:

- It is not very easy to manage a large number of widely distributed small electricity generators which are not linked by communication lines.

- If the consumption level for electricity is as low as it is in most developing countries, the administrative costs for metering and billing are extremely high compared to the investment costs in RE systems.

- In many cases, utilities as well as energy planners do not know how PV systems operate or even do not have the notion of them. They just do not take them into account.

- The ignorance of RE electrification leads still very often to decisions for grid extension in actual off-grid areas though this is even more expensive than decentralised RE electrification.

Many small village or household utilities

While central power stations and electricity distribution grids usually belong to a large, very often national company, diesel motor-generator sets and other local electricity generators are usually owned by companies, village communities or even private persons. It is specific for local electricity supply schemes that owner, operator and user are very often identical, or belong to the same village community, company or family.

Hence, the operator is normally not professionally dealing with energy generation, but rather an individual who is familiar with the electricity generation equipment just as someone is familiar with any other machine. This is possible since the technology used for local electricity production is in the majority of cases much simpler than central generation technology. In addition, the identity of owner and user implies severe financial constraints, since most users are not eligible for bank credits or even totally without the action radius of any credit giving institution.

Local companies involved in renewable energies

The only players who intervene in local energy supply schemes are the supplier and the installer of the equipment, and the technicians who perform the maintenance of the installations. The difference to the case of central electricity generation is, that the supply and installation use to be ensured by small companies. Domestic enterprises are more easily to get involved in such decentralised installations than in larger central schemes which generally imply large orders to foreign companies. In addition, the technicians who do the maintenance may, and use to, belong to local companies.

Financing solutions

The solutions which have been proposed and partially experienced for renewable energy investments in developing countries in the important case of small private investments are similar to those that exist for community level financing. Again schemes developed for agriculture and housing can be adapted and serve as models for renewable energy financing. Bundling of credits, retailer loans, leasings schemes are only some of many possible solutions. In general some degree of self-organisation of different investors, e.g. in co-operatives, and financial intermediates are required.

The issue of securities

A specific problem for small private investments and related financing are credit securities. Private persons in rural areas of developing countries can usually not provide the securities for a loan which banks ask for. A possible alternative has been developed in the agricultural sector by the Grameen Bank in Bangladesh: Credits are only given to groups of 4 or 5 investors where the second investor in the group gets his credit only when the first one has paid a sufficient part of his credit back and so on. This scheme creates security through social control within small groups of people who know each other and has been very successful in Bangladesh. Usual securities are no longer necessary.

Conclusions

Three types of investments have been distinguished by size and investor:

1. large infrastructure investments,
2. community investments, and
3. small private investments.

These types of investment correspond to different level of renewable energy application in developing countries and require respectively a specific approach to financing.

Large infrastructure investments correspond to hydropower plants, large wind parks and biomass power plants. They can be financed in a similar way as any kind of industrial or public investment.

Community and small private investments, however, imply usuall investors who are hardly bankable, a too low size of finance and too much administrative work for being interesting for most financing institutions. The investments at these levels are forest plantations and decentralised renewable energy systems like photovoltaic systems or wind generators. They are particularily important for developing countries, because they are linked to fundamental development problems and offer simple and cost-effective solutions for development.

Schemes for financing such investments can be developed similar to financing con-

Type of investment	(1) Large infrastructure investments	(2) Community investments	(3) Small private investments
Investment to be financed	large electric power stations, e.g. hydropower stations, electric grids, fuel storage and transport infrastructure	fuel wood plantations, community size renewable energy systems (e.g. PV drinking water pumping systems)	decentralised renewable energy systems (PV solar home systems, small windturbines, biogas reactors, solar cookers, etc.) and fuel saving cooking stoves
Investor	large (state-owned) companies	village communities, local cooperatives, etc.	individuals, small companies, schools, health centres, etc.
Investment sum	some 0.1 to 100 MEURO	some 1-100 kEURO	some 10 to 1000 EURO
Specific financing barriers	liability of investor	liability of investor, local presence of financing institution, small size for commercial credit	liability of investor, local presence of financing institution, much too small size for commercial credit
Specific elements of financing solutions	public guarantees	bundling of credits, self-organisation for financing at local level, local financing intermediates	bundling of credits, self-organisation for financing at local level, local financing intermediates, innovative credit securities
Example sectors from which lessons can be learnt	industry, public infrastructure	village infrastructure, agriculture, housing	agriculture, housing
Existing examples	hydropower station investments	community forests in Burkina-Faso	Grameen Bank Bangladesh

Table 1: Comparision of different types of financing situations in the renewable energy sector in developing countries

cepts in the agricultural and housing sector. They requires usually some degree of self-organisation at local level and local financial intermediates in order to channel finance from the large cities to rural areas or for accumulating sufficient capital in the rural areas themselves. At the level of small private investments a further issue requires special attention and creative approaches: securities. An alternative to usual securities might be to interlink the interests of different investors who then take care that all of them pay the received credits back.

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Kenya's PV Market: A Showcase for Commercial Market Development

Moses Agumba and Bernard Osawa

Introduction

The Kenyan Photovoltaic (PV) market remains an excellent showcase that has demonstrated the rural population's willingness to pay for solar electricity is often underestimated. About 150,000 (4%) Kenyan rural households have purchased solar electricity compared to 62,000 connected to the grid through rural electrification program s. The demand for PV has grown exponentially since the mid 1980's courtesy of private entrepreneurs. More than 15 companies based in Nairobi currently supply the market through scores of agents based in the rural areas that market, install and maintain the systems. Amorphous Silicon systems currently dominate the market with an overall average system size of 25Wp. Potential demand is estimated at 25 MWp and is predominantly for solar home systems. Market constraints include, a lack of favourable policies, missing credit lines, lack of enforceable standards, low quality Balance of Systems Components and low consumer awareness. PV systems can potentially electrify 40% of rural households in an economical way. Technical support and strategic financing are the key to strengthening PV infrastructure and reaching rural households.

Introduction

Kenya is a developing and still largely rural country where only 25% of its 29 million people live in urban areas. The bulk of the population is concentrated in the medium to high rainfall areas, which make up only 20% of the total land mass. Population density reaches over 300 per square km in some of Kenya's 'high potential' areas and as low as 5 per square km in others. Kenya's GDP reached some US$ 9.98 billion in 1998[1] with a growth rate of 1.8%. The country is classed by World Bank statistics as a low-income economy with an average per capita income standing at US$ 296 in 1999. Major sectors in the economy are Agriculture, tourism and manufacturing. Of the approximately 4 million rural households, more than 95% are without access to grid electricity. Rural households use candles and kerosene lamps for lighting and dry cells for radios and torches. Lead-acid batteries are also used to power dc electrical lights, TV sets and radios. These lead-acid car batteries are routinely recharged at distant local shopping centres where grid electricity or generator power is available.

Rural electrification programs

Since 1973, the government has undertaken distribution of electricity in areas where the financial viability seems doubtful to the utility under a Rural Electrification Program (REP). The focus of the program is to supply power to agro-based and other small industries, shops, institutions, water supply and

[1] Economic Survey 1999

other public facilities. Individual households are encouraged to hook up to the supply if located within reach of an installed transformer. Since the inception of the Rural Electrification Programs (REP) more than 17 years, approximately 62,000 or 2% of rural households have been connected to grid power at a cost of US$ 600 million. Major obstacles to REPs have been: high capital costs, high revenue collection costs, low income from existing operations, insufficient generating capacity and high connection costs for scattered households. PV has not been considered for rural electrification, as it does not qualify under the Least Cost Extension Programs (LCEP). This is a method used by the government to decide on which power generation options to use.

The Commercial PV Market

Kenya has an active commercial solar home systems (SHS) market, with cumulative sales in excess of 150,000 units and current sales of over 20,000 systems per year. To date more than 3.2 MW of amorphous and crystalline silicon have been installed and the PV industry is worth US$ 6 million in new installations per year (500kW/year). There are hundreds of PV businesses in terms of manufacturers, vendors, installers, and after-sales providers active in the market. The demand for PV has grown exponentially since the mid 1980's, when Kenyan entrepreneurs realised that solar electricity could meet rural electric power demands for domestic use, often at lower cost than grid connections, generators and batteries. The market grew as rural-based artisans formed business agreements with urban solar companies based in Nairobi, thereby increasing the outreach and accessibility to PV equipment. There are presently more than 15 companies based in Nairobi that supply this market. Each company has scores of agents based in the rural areas that market, install and maintain the systems.

Market Development

Since the introduction of PV into the region, the local market has evolved through the following stages:

1985 - 89:

Transformation from donor driven[2] to commercial market. SHS market developed steadily. Over 90% of the modules sold were crystalline. General growth in PV sales was around 5-10% for this period. Typical systems used crystalline modules of about 40 Wp (Acker and Kammen, 1996).

1990 -98:

10 -14 Wp amorphous silicon (a-Si) modules entered the market in 1989, capturing the majority of SHS sales within five years (van der Plas and Hankins, 1998). Since then, total a-Si sales in Kenya have increased dramatically, from 10 kWp in 1989 to 270 kWp in 1998. The relative percentage of complete system sales went on the decline, while the number of over-the-counter, customer-installed systems increased. The bulk of the a-Si modules go to one-module systems.

1998- to date:

Small a-Si systems still dominate the market (by numbers). Average system size currently stands at 25 Wp, implying that most people are buying what they can afford. Potential demand is currently estimated at 25 MWp. Given income structures, the effective demand is about 14 MWp, with more than 50% being 20Wp or smaller systems. The current total installed capacity is estimated at some 3.2 MW, more than 50% being SHS'.

1 shows the estimated module sales by type for the period 1989-1999.

Market Status

Kenya is notable for having mobilised its local entrepreneurial skills in the development of the PV industry. PV dealers can be found in virtually all major towns across the country. Below are the salient characteristics of the market:

- All solar modules are imported. There is no local manufacture. These come with varying warranties.
- Mean system size stands at 25Wp with an average purchase expenditure of US$418.
- More than 50 % of the systems use a-Si modules with a majority of the systems

[2]Relief agencies, NGOs and church organisations introduced initial systems in the region.

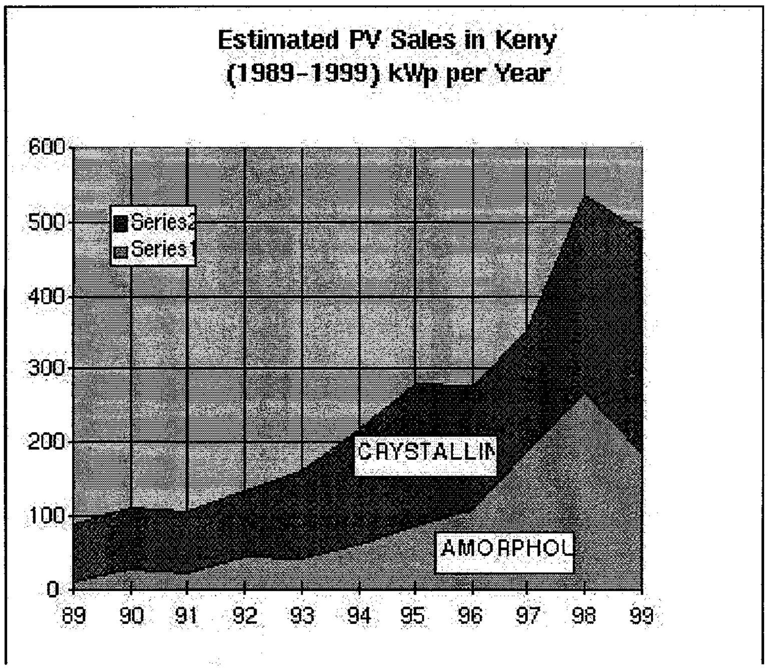

Figure 1: Estimated module sales, 1989-1999.

undersized for their loads.

- Over 90% of the a-Si systems do not use charge regulators.
- Over 90% of the systems use locally manufactured SLI or modified SLI ('solar') batteries.
- Of all the 'Solar and TV" batteries sold to rural Kenya, 30 % are SLI, while 70% are modified automotive batteries. All battery manufacturers currently offer a one-year warranty.
- Over 85 % of the systems power black and white TVs, 84% have lights, while 70% have radios/cassettes. Users are from a wide range of backgrounds, but most have regular incomes. A majority of the users buy systems to run B&W TV, lights and radio together, as opposed to lights only. Customers save up to $10 monthly on kerosene, dry cells and battery-charging expenditures.

PV infrastructure

There is currently a well-developed PV sales and distribution infrastructure consisting of manufactures, dealers and technicians that has identified consumers' needs, and is responding with increased and diversified supply of PV components and technologies in the market. Importers: There are 10-15 importers of modules, lights, charge controllers, inverters etc. These importers have dealers at the regional and local levels. A few of these companies have technical teams that undertake on major projects. Manufacturers: There are 3 major battery manufacturers and a major lights and charge control manufacturer. Another 4 - 15 small-scale manufactures of lights and charge controllers, inverters etc. are in business countrywide. Dealers: This group constitutes the majority of players. There are hundreds of these distributed across the country, mostly selling over the counter and with little technical capacity. Some dealers have technicians (not necessarily trained) that install systems. Technicians: These are mostly independent operators with some knowledge of AC electricity. Few trained solar technicians exist. Tax: There is no rational tax regime for PV products as only modules enjoy special tax arrangements. (0% duty and 5 % VAT). Other

BOS attract relatively higher duties (15- 25 % duty and 15 % VAT).

Sales Methods

A major factor influencing the actual demand for SHS in Kenya is the inability of customers to pay the high up-front costs. Accessibility to SHSs could be greatly increased if financing mechanisms were available. Consumers can either acquire SHSs through cash, hire purchase, and cash-deposits or financed systems methods.

Cash

Cash SHSs constitute the largest portion of systems installed in Kenya to date, but seems to have reached a saturation point. Downsizing of system sizes has offered an opportunity to greatly increase this market segment.

Hire Purchase

Hire-purchase schemes have been tried in the past and are making come back, based on experience in selling consumer goods (TV's, sewing machines, bicycles etc.) to rural people. Repayments are on a "check-off" basis. Sales are rising, but quality of equipment and standard of installation is questionable. Interest rates are above commercial lending rates (average 40%) and repayment period is 24 months at the maximum. Major dealers are working with hire purchase companies towards this end.

Cash-Deposits

Several retailers offer cash deposit system to customers who cannot raise the substantial up-front funds to buy systems in one go. Customers make cash deposits in regular instalments to a solar company and the dealer delivers and /or installs the system upon full payment.

Financed systems

Although there is relatively little experience with financing PV in the region, there is a good deal of experience in Kenya with small-scale consumer and enterprise credit. For the majority of the population, formal credit lines are inaccessible. This is due to inability to meet basic conditions for obtaining loans, including sufficient and legally backed collateral, record of performance with a financial institution and regular income. Even though financing appears to be the best option in facilitating mass rural electrification by solar electric systems, few initiatives exist.

Market Impediments.

Despite the high potential demand for SHS, constraints that have impeded market growth, include:

- Lacking government support
- High consumer prices partly resulting from high tax and duties component, and relatively high transactions costs among dealers and distributors;
- Missing credit lines
- Missing standards leading to low installation standards and practices
- Low quality of available local Balance of System (BOS) components
- Low consumer awareness of the limitations and potential of PV

Recent Projects

This section provides a brief review of some selected recent projects.

ESMAP Solar Finance

In an effort to develop a sustainable financing mechanism to further assist the commercialisation of PV in the country, ESMAP through EAA conducted a pilot Solar Finance Project (1997 - 99). The approach was based on the co-operation of a finance partner, credit group and a technical partner. The objectives of the exercise were to: increase access of SHS through financing, spread-out up front costs, offer savings through bulk purchase to offset cost of credit and to use better equipment. Two approaches were used; K-REP, a rural development bank and the Co-operative Bank of Kenya. Each group used its standard existing system of disbursement. In total 70 systems of sizes ranging from 24 Wp to 60 Wp were installed. Costs varied between US$ 500 and 1,100.

Problems encountered and achievements

The major problems encountered included cohesion among loan groups, changing preferences and local politics. Lack of technical capacity among local installers was evidenced by the low installation standards. The most notable achievement was that the project was used to climb the learning curve and convince bank managers of its viability. Lessons learnt included:

- Banks are not accustomed to consumer credit
- Interest rates must be less than market rates
- Low or no defaults in the case of cooperatives, where recovery was from source.
- For smooth implementation, there must be existing infrastructure
- SHS is not a productive asset
- Substantial technical training was needed as technical capacity was weak
- Time and dedication is essential to implement such projects
- Even if economically viable, initiatives are not always financially viable
- Steady and adequate project preparation support is needed
- Adequate financing mechanisms as well as Information dissemination channels need to be developed.
- Policy barriers need to be removed and duty/tariffs rationalized

Solar for Schools Project

This is a solar awareness initiative implemented by Solarnet, an NGO. Off-grid rural boarding schools receive a 50% subsidy to install solar electric systems and endeavour to use as demonstration installation during school visiting days. To date 10 schools have been evaluated and 2 are going ahead with the systems installation.

PVMTI

This is a US$ 5 million initiative of the World Bank/ GEF aimed at transforming the commercial market. The arrangement requires a 1:1 leverage of funds for participating consortium (financial and technical partner). Minimum disbursements are US$ 500,000 per consortium. This favours the larger Nairobi based companies. To date, two proposals have been shortlisted for financing.

The way forward

To develop the market further, several approaches can be pursued. These include among others:

Support for small players (rural dealers and technicians)

These constitute the majority and have the best contact with end users at the local level. Support should be mainly in terms of technical training (installation and maintenance). Small business support is also necessary to help dealers and technicians set up shop.

Support to large players

Even though these are few, they are the main importers of PV equipment to the country. This is the approach taken by PVMTI. It is anticipated that financing the large players would lead to improved volumes and reduced costs. But given the high business overheads in the country, this might prove to be futile at the consumer level. Raising leveraging funds is proving to be a problem for the local companies. To overcome this, it is recommended that the minimum disbursement be reduced so that many more businesses can afford and benefit from the scheme. However, this will put in a lot of logistical stress on PVMTI.

End-user Financing

By availing loans to end-users through cooperatives or organised loan groups, affordability of systems can be greatly increased. The cooperative movement in Kenya is very strong and is the most strategic entry point. This was proven during the ESMAP Solar Finance pilot.

Development of equipment and installation standards

The government has finally seen the light and has put out a bid for standards development. The Kenya Bureau of Standards is also working towards this end. However a code of practice for technicians still need to be developed while enforcement will be another tall order.

Introduction of fee service payment for solar electricity in rural areas

Energy Service Companies (ESCOs) should be formed to provide electricity by installing and maintaining Solar Homes Systems in the rural areas with no grid lines. This will further make PV to be a key element in rural electrification. It would provide opportunity for international utilities and companies in the north to form partnership with local companies, which will hopefully see innovative and creative minds being applied to the desired rural energy development in Kenya.

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World Bank Support for Renewable Energy - The Asia Alternative Energy Programme (ASTAE)

Noureddine Berrah and Enno Heijndermans

Introduction

The Asia Alternative Energy Program (ASTAE) is a program within the World Bank, with staff and resources exclusively dedicated to the promotion of alternative energy in South and East Asia. ASTAE operates through a partnership with the Bank's client countries, the Global Environment Facility (GEF), and bilateral and multilateral donors.

ASTAE

History

ASTAE grew out of the Financing Energy Services for Small Scale Energy Users (FINESSE) Project, initiated by multilateral and bilateral donors in 1989. Following a joint request from Asian borrowers and donor partners, the Bank acted to implement the FINESSE recommendations by creating the Asia Alternative Energy Unit (ASTAE), as part of the Asia Technical Department, in January 1992.

ASTAE was originally set up as a three year pilot program, with the objective of "mainstreaming" alternative energy in Asia. ASTAE's original target was to increase the share of alternative energy in Bank lending to the power sector in Asia to 10 percent of total power sector lending. ASTAE's life was extended by mutual agreement among the Bank and donor countries. It was redefined from a Unit to a Program in 1998, and has been merged with the East Asia Energy and Mining Development Sector Unit, while continuing to provide support to South Asia.

Activities

ASTAE provides experts and resources to promote Bank lending for alternative energy in Asia by supporting:

- identification, preparation, appraisal and supervision of renewable energy and energy efficiency investments financed by the Bank and the Global Environment Facility (GEF);
- analytical and advisory activities to support alternative energy projects, including formulation of policies to promote renewable energy and energy efficiency options;
- capacity building of client country agencies and Bank staff; and
- coordination with other international agencies and resource mobilization for alternative energy development

Partners

Since its formation, ASTAE has been supported partly by the World Bank and partly by bilateral and multilateral organizations, including: the Dutch Partnership and the Netherlands Directorate General for International Cooperation (DGIS); the US Department of Energy (USDOE) and other US agencies; the United Nations Development Programme (UNDP); the Swiss Confederation; the New Zealand Ministry of Foreign Trade; the Swedish International Development Agency (SIDA); German BMZ/GTZ; European Union;

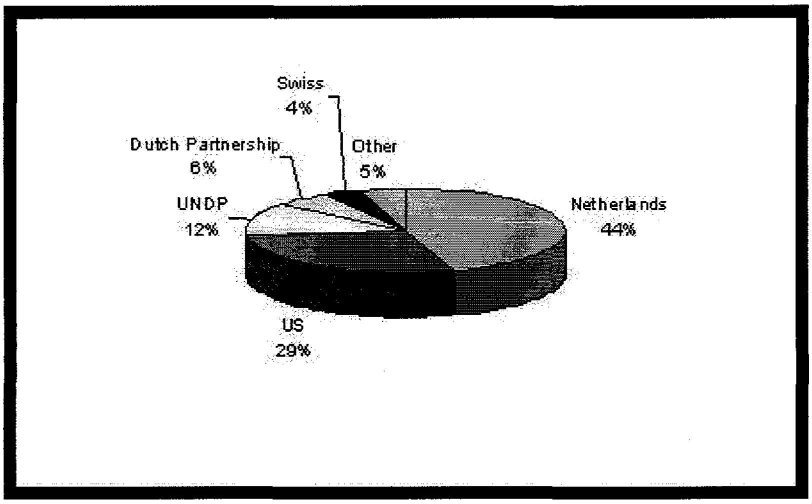

Figure 1: ASTAE Resource Utilization by Donor Funding Source, FY92-FY99

	FY 97	FY98	FY99	FY97-FY99
Financing for Alternative Energy in Asia[a]	76	87	144	306
Financing for Electric Power and Other Energy in Asia	1,155	1,079	310	2544
Alternative Energy Financing/ Power Sector Financing (%)	6.6%	8.0%	46.3%	12.0%

Table 1: ASTAE-Supported WB/GEF Financing for Alternative Energy in Asia, FY97-FY99 (millions). Source: World Bank Annual Report 1999, ASTAE Status Report #6

[a]Includes Bank, GEF and AIJ lending for alternative energy components.

IEA; DANIDA; and the governments of Australia, Finland and Japan.

In recent years, ASTAE's annual budget has varied from $2.5-3.8 million, with consistent Bank contribution of over 40 percent. Figure 1 shows that the largest outside contributors over the entire period have been the Netherlands and the US.

Results: Lending Projects

The South and East Asia regions have the strongest alternative energy portfolio of all regions in the Bank, largely as a result of ASTAE's catalytic support. Since ASTAE's inception, Bank alternative energy lending in Asia has increased from one $2 million solar component under implementation in FY92 to seventeen ASTAE-supported projects currently under implementation, totaling over US$ 550 million in Bank/GEF support for alternative energy. These projects represent total alternative energy investments of over US$ 1.5 billion. These projects are expected to displace about 1 GW of fossil fuel fired generation capacity and will provide electricity to an estimated 530,000-630,000 rural households that would otherwise lack access to modern energy services.

Table 1 shows that ASTAE's original target of 10 percent share of alternative energy in the power sector lending portfolio in Asia was met and surpassed in FY99, with alternative energy accounting for an all time high of 46% in that year. It should be noted that this target reflected not only an increased lending volume for alternative energy, but also a decreased volume for financing for conventional projects. However, alternative energy would have met the 10% target even if lending volumes of conventional energy had been maintained.

ASTAE is supporting project preparation work for an additional 21 projects, with an estimated total alternative energy cost of US$2 billion and a Bank/GEF support of US$530-740 million. ASTAE's FY 93-03 portfolio includes 38 operations in 11 countries with total Bank/GEF commitments of $1-1.3 billion and a total alternative energy project cost of $3.5 million.

ASTAE- supported projects focus on a limited number of well proven applications and technologies, mainly in the power and industrial sectors. Renewable energy projects have focussed on supply of power to the grid (small hydro, windfarms, geothermal, biomass) and providing power to isolated rural households and institutions (mainly photovoltaic systems and isolated hydro). Energy efficiency projects have focussed on power system efficiency, DSM, co-generation, and assistance in developing Energy Service Companies (ESCOs). Projects have significant technical assistance funding for capacity building. Technical assistance has focussed on building capacity from the top down and from the bottom up by strengthening the capacity of: (a) governments to develop appropriate plans, policies and regulatory measures; and (b) businesses to sell, install and operate good quality alternative energy equipment and services.

Results: Analytical and Advisory Activities

ASTAE-supported Analytica and Advisory Activities are designed to assist in overcoming regulatory, technical, financial and institutional barriers to alternative energy and to contribute to appropriate policy environments. The largest share of this work is for strategic planning and sector work (38%), followed by capacity building and training activities (26%), cross-sectoral activities (16%), best practice documentation (8%) and technology, feasibility and resource assessment (combined total of 12%.)

What factors contributed to the growth in alternative energy projects in Asia?

ASTAE was the right idea at the right time

While conventional energy sector lending has not been a major growth area in recent years, alternative energy development has benefited from a rare and powerful convergence of interests. These converging interests are: (a) demand from client countries; (b) interest by the local private sector; (c) relevance to the World Bank's mission of poverty alleviation and growing emphasis on environmental protection; and (d) strong financial support mainly from the GEF, but also from multilateral and bilateral donors. The convergence of interest has grown and strengthened during the seven years of ASTAE's life and continues to grow, as shown below.

Demand from Client Countries

The demand from client countries for alternative energy projects arises from two main concerns: (a) providing universal access to rural electrification; and (b) environmental protection. An estimated 500 million people in Asia are without the benefit of modern services such as electric lighting, fans and communication devices. While access to modern energy is secondary to the more basic issues of survival (food, shelter, cooking fuel, etc.), many Asian governments give high priority to supplying electricity services to households and villages. The commitment to universal access to electricity is one explanation of the strong and growing client demand for alternative energy projects.

A second driver of country demand for alternative energy is concern for the environment and a sustainable development path. This motivation is especially critical in the larger and more industrialized countries such as India and China. In these countries, coal or fossil fuel fired electricity generation is the fastest growing component of energy supply, as residential and commercial electricity demand grows and as industries switch to the convenience of electricity. The high projected growth rates for energy demand present a significant opportunity to displace fossil fuel resources with alternative energy and reduce the emissions of damaging CO_2, NOx, SOx and particulates. Energy efficiency projects are especially attractive for sustainable development because they frequently have high returns on investment in the short to medium term.

Interest by the Local Private Sector

The local private sector is the largest single source of financing for ASTAE-supported alternative energy projects under implementation, an estimated US$675 million. Forty-eight percent of the alternative energy costs of ASTAE-supported projects were financed by private sources, compared to 31% from Bank/GEF and 21% from other sources. Sectoral reforms have helped to encourage this local private sector participation, supported by the changing policy and regulatory frameworks of local governments. The small scale of most alternative energy investments, on the order of tens of millions of dollars, has made the projects attractive to local entrepreneurs and made it possible to finance them through local commercial banks.

Relevance to Bank Mission and Priorities

Alternative energy promotes the Bank Group's main task of fighting poverty, and helping people help themselves and their environment by providing resources, sharing knowledge, building capacity, and forging partnerships in the public and private sectors.

Alternative energy contributes to two separate objectives. It helps to:

- alleviate poverty by providing access to modern energy services for remote rural communities, thereby increasing quality of life, economic opportunities and communication with the outside world.
- protect the environment by providing a clean alternative for electricity and heat production, thereby reducing emissions from burning of fossil fuels while providing economic development opportunities and reducing infrastructure bottlenecks.

The World Bank's central focus on poverty alleviation provides a fertile environment for alternative energy projects. Poverty in rural areas is strongly correlated with isolation and lack of access to services, including electricity. Once basic survival needs are met, providing access to modern energy services is one of the highest priorities of many communities. Access to electricity first lengthens the hours of the day, increasing the possibility of either more economically productive activity, leisure or studying/reading. It also reduces the sense of isolation and increases people's knowledge of the outside world, which has the potential to empower people by increasing choice and security.

The two objectives of extending access to modern energy to rural populations and environmental protection, are largely separate. However, while projects focused on environmental objectives do not necessarily contribute to extending access of rural populations, the reverse is not true. Projects to increase rural access using alternative energy do contribute to environmental objectives. For this reason, GEF has been willing to support alternative energy projects that have the purpose of extending electricity access in rural areas. The GEF is willing to support these projects for two reasons: (a) GHG emissions are reduced by replacing gasoline and diesel (for generators), and/or kerosene (for lamps) and other fuels that would otherwise be used for lighting; and (b) an expanded use of certain key technologies, such as household-scale solar PV, is expected to reduce the costs so that the technology will be used in larger-scale applications where the GHG mitigation potential is much greater.

Environmentally Based Support from the GEF and Bilateral Partners

Grant support from the GEF has been critically important to ASTAE's ability to promote alternative energy lending, as has support from multilateral and bilateral donors. Alternative energy projects are sometimes more expensive to implement than conventional alternatives. Furthermore, their environmental benefits are typically not reflected in the marketplace. The availability of GEF grant funds to offset higher incremental costs of alternative energy, as well as to remove barriers and to offset risks during project implementation, has been a determining factor in the acceptance of alternative energy projects by client countries and by Bank staff and management. Most ASTAE-supported renewable energy operations and energy efficiency operations have been developed with GEF assistance.

However, even with the support of the GEF, additional donor support has played an important catalytic role. The importance of donor trust funds for catalyzing identification of alternative energy project cannot be overstated. These funds have enabled ASTAE staff to move quickly in response to project opportunities, and have provided "seed funding" for reconnaissance work, pilot projects and sector work. Without these initial reconnaissance efforts, it is likely that alternative energy components and projects would not have received project preparation funds from the Bank and the GEF. ASTAE staff also have tapped Bank-wide Trust Funds with considerable success, because many of these funds also favor investments with strong relation to poverty alleviation and/or environment.

What operational approaches have been used to develop the ASTAE-supported portfolio?

While there has been a favorable environment for alternative energy in recent years, this was a new area for Bank lending seven years ago. ASTAE had to work to catalyze the demand for alternative energy projects-in client countries and within the Bank. Several factors were key to this effort-a clear mandate and performance indicators; a strategic approach to project development that stressed awareness and capacity building; and its regional location in Asia.

Mandate and Focus

From the start, ASTAE management has had a clear mandate: to mainstream alternative energy. This objective was more finely focused and clearly conveyed to staff as a mandate to incorporate alternative energy into Bank projects in the Asia region. All activities, including project and sector work, as well as conferences and study tours, have been undertaken in support of this mandate. The initial target agreed with donors, to lift alternative energy lending to 10% of overall Asia energy sector lending within 5 years added further specificity to the mandate.

The power sector was the obvious target for initial ASTAE activities, and remains the primary focus of activity. This is due to the high client demand for grid and off-grid energy operations, strong presence of the Bank in the sector, and keen interest of donors in supporting such operations. This sectoral focus is reflected in the program's current administrative location, in the East Asia Energy and Mining Development Sector Unit.

Approach to Project Development

ASTAE has used a three pronged approach for alternative energy project development, involving awareness and capacity building as complementary activities to project preparation.

Awareness building of alternative energy potential, is the first element of this approach. The effort required to establish alternative energy as an option for energy service should not be underestimated. People at all levels, from ministers to village households, are more comfortable with conventional approaches even when alternatives are less expensive and more reliable. An example of awareness building activities can be seen in the energy efficiency activities in Thailand. In Thailand, a UNDP pre-feasibility study combined with ASTAE-sponsored twinning and technical assistance activities led to a DSM operation with the distribution utilities. A follow-up ASTAE-assisted workshop led to increased private sector interest and the identification of a new GEF project to develop the market for energy services companies (ESCO's).

Alternative energy client country capacity building, in both public and private sectors, is the second element of the approach. This work focuses on increasing: i) government capacity to create an enabling environment for investment; ii) capacity of financial institutions to include these new options in their portfolio; iii) technical capacity of the industry to appropriately design, specify, possibly manufacture, install, and service equipment; and iv) managerial/business capacity of the supply/delivery/service chain to ensure that ultimate clients receive adequate service at reasonable costs. ASTAE has made extensive use of local consultants to undertake this work.

Awareness and capacity building are closely tied to project identification and preparation, the third element of the approach. In keeping with the Bank's rigorous analytical approach, the viability of proposed alternative energy options are analyzed as part of project preparation, (in comparison to conventional options), to ensure that they are least cost and most appropriate for the task at hand. ASTAE has had good success in using participatory approaches to build consensus for project development through the Object Oriented Project Planning (OOPP) methodology, which has been used in projects in China, Vietnam, Sri Lanka and the Philippines[1]. This methodology brings together project stakeholders for structured brainstorming sessions.

Regional Focus and Location

A key factor was a regional focus and an organizational location of staff close to the East and South Asia staff with which they work. The program still maintains this focus, despite its migration from the former the Asia Technical Department to its current location in the East Asia Energy and Mining Development Sector Unit. The regional focus allowed a concentration of effort to show measurable impact, while not unduly limiting the field of opportunities. The regional location facilitated development by program staff of long-term relationships with regional Bank staff and clients.

What is ASTAE'S strategy for the future?

Alternative energy has grown from the Appropriate Technology movement of the 1970's to a multi-billion dollar business today. The business includes manufacturing of alternative energy equipment (renewable energy and energy efficiency), research and development, consultancy services, installation and maintenance services, awareness creation, education and publication. The growth in the alternative energy business has been created by environmental concerns, by the reduction of alternative energy cost and by increased capacity to develop such projects. Continued rapid expansion of demand for alternative energy services is expected over the next several decades.

When ASTAE began its work in 1992, alternative energy was rather new in the World Bank and new for many client countries. Developing a small alternative energy lending operation was a significant achievement. Capacity building was very important but was mainly project based. Because projects were relatively small they were not able to leverage policy reforms which could benefit all alternative energy projects.

Much more capacity is needed in client countries to capitalize on the interest and opportunities created by the GEF and the other mechanisms described above, and to make a measurable impact both on protecting the environment and providing remote rural access to modern energy services. The capacity building done in our client countries is only a fraction of what is required to achieve a measurable and lasting impact on increasing both rural access to energy and environmental protection.

To make a measurable impact in reducing greenhouse gas emissions and providing remote rural access to modern energy, more and larger alternative energy projects are required. More meaning not only more projects supported by the World Bank and other bilateral and multi-lateral agencies, but more broadly, more projects that involve the public and private sector domestic investors as well as NGOs and INGOs. This requires the development of broad based local capacity to develop and implement alternative energy projects.

The World Bank is well placed to assist in developing this capacity, but doing so requires a shift from working on single projects to working on a programmatic basis. The project concepts should focus more than in the past, on building capacity and providing the momentum for policy and institutional change, mainly appropriate policies and incentive mechanisms to increase the sustainability of alternative energy. This approach requires focussing on selected countries that have significant potential and strong commitment to alternative energy development. A consequence of the programmatic approach is that the funding requirement will be bigger, providing greater incentive for client countries to adopt appropriate policy and regulatory mechanisms.

Creation of an Enabling Environment

In the absence of monetization of environmental externalities in the marketplace, large-

[1]The OOPP methodology is described in detail in "Quality Management of Development Cooperation" (UNIDO, Vienna, 1997). See Parts 1-3.

China/WB/GEF Pilot Project Under Strategic Partnership For Renewable Energy Development

The Project aims to support the GOC Renewable Energy Program to be presented in the 10th and 11th Five Year Plans. The objective would be to reduce environmental emissions from coal fired power generation by developing sustainable commercial markets for electricity from renewable energy. This would be done by creating a mandated large-scale market and reducing costs for mature technologies such as windfarms, small hydroelectricity and biomass.

Preliminary discussions indicate that the Partnership would assist the GOC Program in four main ways, by supporting: development of an institutional framework for renewable energy including policies, laws and regulations needed to create a large-scale market;

- actions to reduce the cost of renewable energy and make it competitive, including technology improvement to assist local manufacture of good quality equipment to reduce cost;
- building local capacity for project development and financing as well as efficient operation and maintenance of facilities;
- if necessary, selected demonstration and investment projects that have strategic importance.

Table 2:

scale alternative energy development requires that countries establish an institutional, policy, financial and regulatory framework that helps attract capital from international financial institutions, export credit agencies and, most importantly, the domestic and international private sector. This framework or enabling environment would require measures to:

- stimulate the market for electricity or energy savings from alternative energy;
- provide adequate incentives to mobilize investment by public/private entities in alternative energy facilities;
- facilitate alternative energy project development, including clear and transparent rules, procedures and approval processes;
- encourage development of mature, internationally competitive local manufacturing industries for alternative energy equipment;

ASTAE and the World Bank are well placed to assist client countries to learn from the approaches that have been used in different countries to create an enabling environment for alternative energy, and to adapt existing mechanisms or develop new mechanisms that are suitable to the circumstances of each country.

Programmatic Approach

A small stand alone alternative energy project with no clear prospect of serious follow-up would not be able to encourage or persuade governments in developing countries to put in place the right policy measures with appropriate incentives or to attract significant private sector interest. This would be the case if a programmatic approach was being implemented, with good prospects for follow-up or follow-on activities.

A new initiative by the WB/GEF, the Strategic Partnership for Renewable Energy Development, will greatly facilitate work on a programmatic basis in this area. This initiative, approved by GEF Council and the Bank Board in early 1999, seeks to shift efforts from an individual project approach to long-term programmatic pathways, providing developing countries the time and resources required to develop renewable energy markets and technologies in a sustainable way. The Partnership will support 8-10 year country programs, and will make available a larger amount of GEF resources, targeting them to building effective bridges to private sector market development and financing. There will be a one-time GEF program approval, coupled with delegated project approval authority and ex-post reviews, to facilitate processing. ASTAE is supporting the Bank's preparation of a pilot project in China under the Strategic Partnership (see table 2). It is hoped that the Bank and the GEF will also consider a similar program approach in energy efficiency.

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Public Private Partnership for Financing Renewable Energy Projects in Emerging Markets

Klaus Schätte and Robert Grassmann

Introduction

Subjects covered:

- Public-Private-Partnership-Projects
- Will you assume measures in areas such as environmental protection, qualification of suppliers or workers, technology transfer from Germany or other fields with a sustainable positive effect in your country in connection with an investment?
- Are you planning to involve a German company in a future investment or is your company a joint venture/ subsidiary of a German company?
- Would you like to do more in these fields - but the projects cannot be realised because of lacking funds or special risks?

Public Private Partnerships (PPP) - what does it stand for?

Private enterprises increasingly engage themselves in fields which are also of high interest from a development support perspective. Entrepreneurs invest in countries, transfer technology and entrepreneurial know-how, train employees, raise environmental standards - and do much more. Clearly there must be an overlap between public development objectives and entrepreneurial goals, there must be common interests. The logical consequence is to pursue these interests together.

The Public-Private-Partnership (PPP) programme supports private sector measures positively effecting a sustainable development, which are closely connected to an investment. Special regard is given to the fields of environmental protection, training, infrastructure, quality control, technology transfer, adjustment of procedures to local circumstances as well as health and safety measures. The use of PPP funds is suitable when measures are not legally demanded and implementation would fail to materialise in their absence. PPP cannot be utilised for funding the core business of a company.

Who benefits from PPP?

PPP can be utilised by German companies and their subsidiary companies, i. e. joint ventures with German partners or wholly German owned enterprises in developing countries.

What is in it for you?

The funds allocated within PPP shall, in general, amount to a maximum of 50% of the costs of an individual activity that is eligible to receive support. The contribution through the PPP programme should not exceed EURO 200,000.–. The level of the public contribution will be individually decided for each case. We provide competent and country-specific advice to support PPP activities in all phases. We will also gladly inform you about possible cofinancing of the original investment project by the DEG. We provide long-term loans, equity-type loans or even equity holdings.

What do you have to do?

Please briefly introduce your project to us (a checklist is given on the next page). We will evaluate your proposition and check if it is eligible for support on the basis of a Apublic-private-partnership@. If you have questions in this regard, please feel free to contact us.

Who is your partner?

For over 35 years the DEG has supported entrepreneurial activities in developing countries through financing and advisory services. Our main objective is to uplift the living circumstances in these countries through sustainable economic growth. This necessitates the establishment and development of efficient private sector enterprises. We mobilise long-term investment capital, technical, management and marketing expertise and thus provide on-going support at all levels of a project=s development.

Four examples for development partnerships with private enterprise:

Industrial waste water treatment as a BOT model in Mexico

In the mid-nineties, a German waste water and waste treatment firm set up a company with local partners in Mexico. Interest in the technology offered was keen from the outset but small and medium-sized companies in particular had considerable problems financing the facility. As part of a BOT scheme, the enterprise then offered to clean organically contaminated waste water at small and medium-sized enterprises itself with mobile plants.

This BOT model was very well received and the plans are to extend it to include large stationary plants. This will require intensive training for installation, operating and maintenance personnel. From PPP funds DEG assists training measures in Mexico and Germany and has facilitated the installation of a stationary waste water treatment plant at a Mexican motor vehicle supplier, which started operation near Mexico City in February 1999. The success of this demonstration facility has led to subsequent orders. Another facility has already been installed.

Ecological market gardening in Tunisia

A German company engaged in biological farming is planning a joint venture with a Tunisian trading firm. During the winter months, the joint venture is supposed to produce tomatos, peppers and gherkins for the German market first and then the European market.

In the test phase greenhouses are scheduled for construction covering up to 2.5 ha, with subsequent extension plans. DEG is assisting the pilot phase with PPP funds and has also provided DM 1.2 million from its own funds as a long-term loan to finance the investment. So far, no experience has been gained with extensive ecological vegetable growing in greenhouses in Tunisia. If successful, this pilot project will create about 70 jobs in the infrastructurally weak South of the country, earn export revenue and also afford various opportunities for cooperation with Tunisian agricultural research institutes.

Master craftsman training in the PR China

In the Chinese inland province of Guangxi a German gear and axel manufacturer for building machines founded a joint venture in 1996 with China's largest building machine manufacturer. Production operations require qualified manpower - business and technical professionals who are unavailable in the underdeveloped region.

In a 120-day course Chinese skilled workers are being trained on modern CNC-motorized metal-turning lathes by German master craftsmen and skilled workers to qualify them as foremen and master craftsmen. DEG will bear a part of the costs of this training project. So German enterprises can set exemplary quality and training standards in the region and help secure jobs.

Windparks in Ghana

A German enterprise in the wind energy sector plans to set up several windparks in Ghana. Extensive wind measurements are required at the scheduled locations. DEG is assisting with the wind measurements and the necessary measuring facilities as a pre-investment measure drawing on funds available through the Public-Private Partnership Programme.

The measurements are an essential element for project planning. The use of modern, environment-friendly wind power technology would improve Ghana's power supply and save on energy imports. The windpark would create about 240 new jobs for qualified local personnel.

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The DEG is Germany's finance and advisory institution for the promotion of private sector growth in Africa, Asia, Latin America as well as Central and Eastern Europe. PPP is a new support programme of the German Federal Government. Its objectives are to strengthen and intensify private sector initiatives in developing countries and newly industrialised countries. The DEG was selected to administer this programme.

EIB (European Investment Bank) Lending for Renewable Energy

Nigel Hall

Introduction

This presentation is aimed at providing an overview of the European Investment Bank's activities in the renewable energy sector, with a particular focus on the potential for lending in developing countries. After some general background information on the Bank, a description is given of the resources available for lending to countries outside the EU. The Bank's appraisal procedures are then explained, with details of lending in the renewable energy sector in recent years, and finally the potential for lending for smaller-scale de-centralised renewable energy projects is discussed.

The European Investment Bank

Background

The European Investment Bank is an autonomous institution that was created in 1958 by the Treaty of Rome, which established the Common Market, the forerunner to today's European Union. It operates on a non-profit basis, providing long-term loan finance for capital investment projects furthering EU policies. The EIB is completely independent and raises its financial resources on the capital markets to invest in projects; it is not funded from the Union's budget. The EIB benefits from a "triple-A" credit rating which is due to, and relies on, the soundness of its credit policies and financial operations, the quality of its loan portfolio and the financial strength of its owners, the fifteen member states of the European Union who subscribe to its capital. This credit status enables the Bank to raise large volumes of funds at attractive terms.

The Bank works closely with the Member States and with the other institutions of the EU, including the European Council and the Commission. The Bank's primary objective is to finance projects that promote the balanced development and integration of the Union. Outside the EU, the EIB supports the Union's aid and financial co-operation policies. These are aimed at fostering sustainable social and economic development in developing countries, together with their progressive integration into the world economy. Particular emphasis is given to projects forging closer links with the EU and encouraging joint ventures between local promoters and EU companies.

The volume of the EIB's operations has grown steadily during its 40-year life and today it is the largest multilateral financial institution as well as the world's largest non-sovereign borrower. Over the five year period from 1995 to 1999, it provided over EUR 132 billion, of which EUR 17 billion were for projects outside the EU.

Lending mandates outside the EU

The Bank operates outside the EU under a number of different financial protocols attached to association and co-operation agreements between the European Union and countries in other regions. These include 12 countries in the Mediterranean region (Euro-Med partnership), 11 countries in Central and Eastern Europe (CEE), 30 countries in Asia and Latin America (ALA) and, under the Fourth Lomé Convention, in 71 African, Caribbean and Pacific (ACP) States. As from June 1995, the Bank has also been authorised to operate in the Republic of South Africa (RSA).

In December last year the EU Council approved amounts for several new mandates covering the six-year period from 2000 to 2006. The lending packages are as follows:

- Central and Eastern European Countries, EUR 8.7 billion;
- non-EU Mediterranean countries, EUR 6.4 billion;
- Asian and Latin American countries, EUR 2.5 billion; and
- South Africa, EUR 0.8 billion.

The second financial protocol of the Fourth Lomé Convention, covering lending to ACP countries during the period 1996 to 2000, provided for the Bank to lend EUR 1.0 billion of risk capital, supplemented by EUR 1.7 billion in loans from the EIB's own resources. Risk capital operations are funded from the EU budget (European Development Fund) and can take a variety of forms, including direct and indirect equity participation, subordinated debt, support for privatisation purchase schemes and loan guarantee funds.

Details of the framework for lending in ACP countries after the current protocol has expired is currently under discussion, however it is expected to include a similar package of resources, with special support for infrastructure projects in the least-developed and post-conflict countries as well as for projects with clearly demonstrable social or environmental benefits.

Loans made under the above mandates are provided with a political risk guarantee, to cover risks associated with expropriation, war, civil disturbance and the availability of foreign exchange. This guarantee is supported by the EU budget and is offered at no cost to borrowers.

Loan conditions

The role of the EIB is complementary to the rest of the financial sector - unless there are exceptional circumstances, the size of the loan provided by the EIB is not more than 50% of the outturn cost of a project. Normally the proportion is lower, typically in the region of 25-30%, and the EIB usually expects a solid commitment by the project promoter from its own funds.

In practical terms, the Bank can bring specific advantages to the table, including loans with long maturities, typically from 10 to 12 years for industrial projects and from 12 to 15 years or more for infrastructure projects, at a cost that reflects its rating on the capital markets and the small margin required to cover its expenses. Loans from the Bank's own resources made under the Lomé Convention are eligible for interest rate subsidies provided from the European Development Fund, and a similar mechanism is likely to be available for specific projects under the new protocol for lending in the ACP region.

The resources provided under the various lending mandates are equally available for private sector and public sector promoters, the main difference being that private sector borrowers, not benefiting from a sovereign guarantee, are required to provide a first class guarantee for the Bank's loan to cover commercial risk associated with the project.

Project appraisal

The EIB's dual role as a bank, operating on sound and prudent business principles, while simultaneously being a non-profit making institution conceived to further the policy objectives of the EU gives the EIB a different perspective from the commercial banking world. In order to fulfil its remit, in addition to a thorough financial analysis of its borrowers, the EIB carries out a full economic and technical appraisal of the projects it is asked to finance. The EIB places particular importance on the environmental impact of projects and has to be sure that all projects that it is involved with meet certain conditions, including no unacceptable long term damage to the natural environment and clear plans for making good any short or medium term damage. A full Environmental Impact Assessment (EIA) is required for large projects with potentially serious negative environmental impacts.

So far as the layout and content of investment proposals are concerned, the range and diversity of potential projects makes it impractical to impose any strict standardisation and the Bank does not require potential borrowers to complete set forms or questionnaires. It is left to the initiative of the promoter to compile as detailed information as possible to facilitate appraisal of the project. If the conclusion of the appraisal is positive, the EIB's Management Committee submits the project to the Board of Directors, which decides on the granting of the loan, taking into account the opinions of the various parties involved, including the European Commission and the State in which the project is located. A set of guidelines covering the information required by the Bank, together with details of how to get in touch with the EIB, are included in Annex I.

EIB lending for renewable energy

The economic benefits of renewable energy projects

The Bank has recognised for many years that renewable energy in its various forms (wind, biomass, hydro, solar, geothermal, etc.) can provide benefits when compared with conventional fossil fuel-fired generation. Apart from the role that they play in reducing dependence on oil imports, renewable energy projects have the added attraction of reducing the overall emission of carbon dioxide (CO_2) and other polluting gases at a time of increasing interest in climate change and air quality.

The Bank's statute requires that its funds are employed as rationally as possible and where the execution of the project contributes to an increase in economic productivity. In practical terms, this requires the Bank to be satisfied that a particular project represents the "least cost solution" when compared with the available alternatives. Comparing a renewable energy project with alternative power generation options may reveal that the investment and operating costs over the lifetime of the project, taking into account the associated costs of transmission and distribution, are less than that of alternatives, in which case the economic justification is likely to be straightforward. In many cases, however, the benefits of renewable energy are not explicit, as they accrue not just to the project promoter but to the wider environment, by virtue of avoiding, in particular, the atmospheric pollution caused by fossil fuel fired generating plant. Despite the uncertainty over the significance of external effects described above, many countries have agreed in principle to restrain the emission of greenhouse gases so as to avoid possible negative impacts in the future (the so-called "precautionary principle").

Notwithstanding this, in order to be eligible for a loan from the EIB, all projects must be able to demonstrate both economic and financial viability, so that even if a renewable energy project can be shown to have significant external economic benefits, the revenues generated by the project must be sufficient to support the capital investment required. In many cases, developing countries do not have financial resources available to compensate renewable energy projects for the external benefits that they provide and it is only those projects that can compete directly with fossil fuel-fired generation that can be implemented. In the past, this has largely restricted the field of the Bank's involvement to hydroelectric schemes, although this is not always the case, as evidenced by the Bank's recent participation in projects in the wind, biomass and geothermal sectors (see below).

Other benefits of renewable energy projects may result from decentralised production and increased security of supply, while the sector also has the potential to provide a significant net increase in employment, in particular among the many small and medium-sized businesses involved in the sector. Its development also offers substantial opportunities for export by European businesses, many of which are World leaders in the field of renewable energy technology.

EIB loans for renewable energy projects

As in all other economic sectors large-scale renewable energy projects are financed by means of individual loans concluded either directly with promoters or indirectly through financial intermediaries while small and medium-sized ventures are normally funded through global loans. The latter are essentially lines of credit that are made available to local banks or financial institutions for on-lending to private businesses and public sector promoters.

So far as statistics are concerned, during

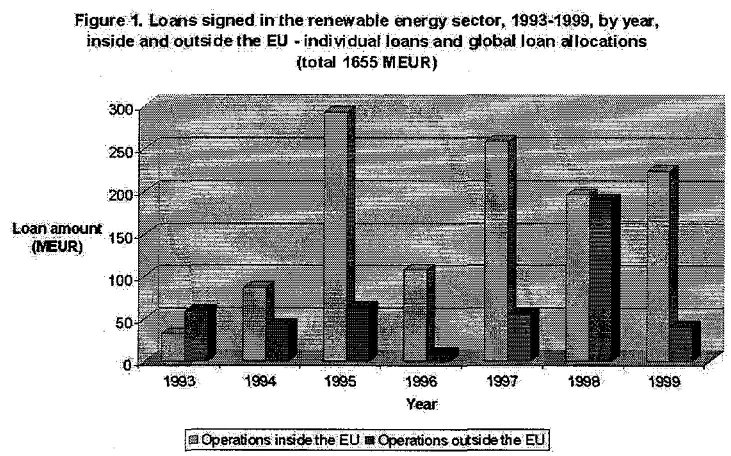

Figure 1: RE Financing

the year period from 1993 to 1999, the Bank signed loans in volume terms of around EUR 1.65 billion in support of renewable energy projects - see figure 1. This represents just over 5% of the total amount provided in the energy sector as a whole over the same period. 72% of financing for renewable energy between 1993 and 1997 was for projects within, and 28% outside, the European Union.

EIB lending in the sector was dominated by hydro-electric projects (78%), with some windpower (13%); other subsectors included geothermal schemes (6%) and biomass-fired power plants (3%) - see figure 2. In total, projects involved the installation of 3 878 MWe of new capacity and the refurbishment of 4 233 MWe of existing plant.

Within the EU, EUR 981 million was provided for a total of 15 individual operations, including hydro-electric plants in Italy, Austria, Sweden, Spain, Portugal and Finland; wind farms in Spain, Italy and Germany; geothermal power schemes in Italy; and power plants fired by wood and other biomass in Sweden. A further EUR 213 million was provided through global loans, mainly for windpower and hydroelectric schemes.

Outside the EU, 19 loans were made to the renewable energy sector from 1993 to 1999, for a total of EUR 459 million. Loans during this period were predominantly for hydroelectric projects, mainly in Africa, but also included a large-scale wind power project at Koudia Al Baida in Morocco, a bagasse- and coal-fired power station at Belle Vue in Mauritius and geothermal power plants in Iceland and Kenya.

Although renewable energy sources are widespread in many parts of the world and offer considerable advantages over the burning of fossil fuels, their potential has, so far, not been fully exploited and renewable projects remain a relatively small proportion of the Bank's portfolio of energy sector loans. This may be due to several factors: firstly, although operational expenses may be low, there is often a comparatively high initial investment cost, which increases the financial exposure at the beginning of the project's life, making them harder to fund. Furthermore, renewable energy projects may involve new and relatively unproven technology, implying a correspondingly high level of technical risk and making them difficult for investors to assess. So far as the Bank is concerned, the size of many projects falls below the threshold for a direct loan, and global loan intermediaries may not have the expertise to appraise this type of project. Finally, in many cases projects provide external environmental benefits that are not fully compensated by the financial returns to the promoter.

Decentralised "off-grid" production

Much attention has been focused in recent years on the potential for renewable energy technologies to provide electricity to remote communities in developing countries that do

Figure 2. EIB lending in the renewable energy sector, 1993-1999, inside and outside the EU, by type of project (Total 1 655 MEUR)

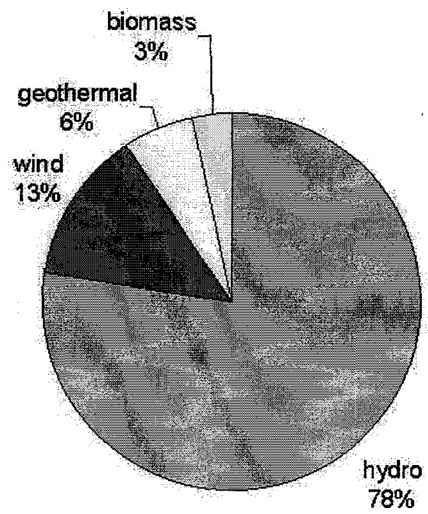

Figure 2: Project types financed

not have access to a centralised electricity distribution network. Examples include individual photovoltaic systems, biomass plants, wind turbines and small-scale hydro-electric schemes. Although the Bank is fully prepared to consider support for such schemes, it is a pre-requisite, as for all other projects, that each project is financially viable and offers the most effective technical and economic solution in the particular circumstances. It is also a requirement that procurement be carried out using open and competitive procedures. An inherent difficulty so far as access to EIB funding is concerned is the small scale of individual projects and the modest financial strength of many project promoters, which can make the necessary loan guarantees hard to obtain. Nevertheless, the Bank is ready to consider possible solutions, such as the provision of a public sector loan guaranteed by the state for on-lending to individual promoters or a global loan to a local financial intermediary for financing small-scale projects or "micro-utilities".

Future opportunities for renewable energy - EIB support

From the Bank's perspective, future prospects for the sector are promising, due to a number of factors:

- technologies are improving, leading to increased efficiency and reliability; o costs are falling, in some cases quite rapidly (in the windpower sector, for instance, real prices per kilowatt have fallen by around two thirds over the last fifteen years);
- the renewable energy manufacturing and service industries are maturing;
- and, last but not least, public attitudes towards the use of renewable energy are, in general, highly supportive.

These trends all contribute to making renewable energy projects more "bankable", even though in some cases a blend of loan and grant finance may still be needed to make projects financially viable. As a consequence, although EIB lending has so far concentrated on the more commercially and technically developed sectors such as hydro-electric and windpower, and other renewable energy schemes (e.g. biomass, charcoal, wood, solar and geothermal projects) so far play little part in the Bank's loan portfolio, this could be expected to change in the future as alternative technologies become more commercially viable.

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The Emerging Role of Carbon Credits in Renewable Energy Project Financing

Marc Stuart

Introduction

Everything we've been talking about over the last two days has a secondary byproduct, which is the reduction of emissions, which is generally a service for the global commons. Emissions trading is basicly taking that service and turning that service into a commodity that is tradable. Ultimately, what I'm going to discuss is taking that commodity at this juncture, and over the next several years, and using the value of that commodity to help arrange financing.

Various people have said that money isn't everything when it comes to getting renewable energy projects up and running. I agree, but it doesn't hurt. This is clearly a value that appears to be moving towards reality. The nice thing about the money that comes from emissions trading and from transactions of emissions is that it is performance-based. It's not necessarily all up-front money which can be lost in the future.

Sources of the current emissions trading dynamics

The Kyoto Protocol will be implemented between 2008 and 2012 for industrial countries. There will be a shortfall in terms of emissions that will be emitted by those countries and what they are allowed to emit, somewhere between 500 million and 3 billion tons per year. This is dependent on various different factors.

Last year we were commissioned by the UN to look at this. I hired an economist, and handed her a stack of paper about a meter high, and I said "tell me exactly what all this means". She said that the assumptions are so different among the different studies you read that you cannot take any one study to be correct, in terms of commercial diffusion of new technologies, assumptions behind emissions trading, or issues regarding forest sinks. As such, we use the 1 billion tons per year as a nominal figure, but this could be off as well.

Either end is significant. 500 million tons of CO_2 reduction requirement to come out of the developing world is a substantial amount. What is happening is the Kyoto Protocol is enhancing the use of renewable energy, and higher efficiency in conventional power plants. This outcome is being further enhanced by the fact that we have technologies that are advancing, such as wind, fuel cells, solar, PV, etc. It's a nice circular loop – we have on the one side a new dynamic that's pushing this to occur, and on the other side we have technologies that are moving forward.

Trends in industrial countries

In industrial countries, there will be very standard positive dynamics occurring to enhance renewables. You'll see a continuance in the enhancements of such things as new tax credits. You'll see power purchase agreements that are more favorable to renewable energy. What is new is that you'll see that renewable energies in industrial countries will have an enhanced competitive status, because:

- They won't have to pay emissions tax.
- In areas where you have emissions trading in a domestic context, they will not

need emission permits to supply electricity or their electricity product into the marketplace.

These are advantages that will continue the circle of technologies getting better and policies to enhance those technologies allowing that to occur.

Emissions reduction and emissions trading

There are two potential points of entry for developers of emission reduction projects in emissions trading.

- They can earn allowances in industrial countries.
- They can create credits in developing countries.

Key questions are: "What is the difference?" and "How do the differences impact strategies of developers in assessing the relative value of different assets?"

Within industrial countries, the allowed emissions under the Kyoto Protocol is that we have a capped volume of allowed emissions. For example "I can emit a million tons, he can emit two million tons" etc. This is what we mean by "capped". We can redistribute within that, but we cannot grow the allowed emissions within the various different parties.

The only way a renewable energy developer actually gains credits is if there is a specific legislation or agreement that allow them to earn allowances from that pool of allowances. This occurs in the United States with sulfur dioxide (SO_2) trading. There is a mechanism whereby renewable energy can earn SO_2 allowances, then sell them into the market. We have the model of the global greenhouse gas market in the US in SO_2. Renewable energy for, I believe, every 50 MW·h can earn one SO_2 credit. As it currently stands, that's not worth very much – it only adds perhaps a half a percent to one percent to the value per MW·h. This is simply because when the legislation was created, that was the multiplier that they used.

There are no credits in developing emission reductions or developing renewable energy projects in the industrial world. There is only the potential to earn allowances, and those will be case-by-case in each country according to various different policy parameters.

Emissions trading and developing countries

In developing countries, however, you can earn credits. What this means is that rather than having our own particular pool of allowed emissions, I could go to somebody else, such as Brazil, China, or India. If I was to demonstrably reduce emissions in those countries to the satisfaction of regulatory authorities, I could import those credits, which now would be the equivalent of allowances and grow the initial pool.

The mechanism under which this occurs is called the "clean development mechanism" or Article 12 of the Kyoto Protocol, and the commodity is referred to as a "certified emission reduction". Note that the word "certified" is very important.

One point I make here is that allowances as we discussed them – the allowed emissions among industrial countries – are only good between 2008 and 2012. Theoretically, we can start earning certified emission reductions under the clean development mechanism from this year onward, banking emission reductions up to the year 2008.

For developing countries, this is potentially a huge advantage. Ultimately, any investment I make in emission reductions in, say, Russia, Poland, or the United States, only has value emerge under the Kyoto dynamic as of the year 2008. Under the clean development mechanism we can begin earning credits, which can be used in that pool, and that earning of credits can occur over the next seven years.

Assets under emissions trading

How do we evaluate an asset under emissions trading? There are three main components:

- What is the asset? What are the emissions?

My company is fairly agnostic about this - we don't only deal with renewable energy. We also work quite a bit in forestry, power plant upgrade efficiency, and transportation, for example.

In most renewable energy, the general assumption is that the emissions profile of the renewable energy asset is zero. This may change for some types of technologies, and when people start looking more carefully at life cycle emissions.

However, it's more important where the asset is than what the asset is. You have to consider what's called the "emissions baseline" of the sector in question – electricity, for example.

When we're looking at small-scale renewable projects, we're generally looking at something along the lines of a diesel generator of a particular efficiency, which can be found in that particular area. When we look at industrial-scale projects, obviously the general background to how that commodity – electricity – has been produced in the past, and is projected to be produced in the future is extremely important. Therefore, we get into geographic differentials. For example, China is better for this than Brazil, because the Chinese electrical grid is reliant on black coal, whereas Brazil is mainly using hydro power and gas at this point.

- What is the current attitude of the government towards transferring credits?

For example, Costa Rica is better than China. I know that if I go to Costa Rica, I have a very good chance of easily earning credits. They will stamp the approvals I need to earn those credits much more quickly than in China at this juncture.

- Can the performance of the project be readily be certified?

You need to be able to quantify the emission reductions in a credible fashion that is acceptable to the international community. There are already a number of international certification agencies emerging to do exactly that. A difficulty with small-scale renewables is that it is often very hard to certify performance in term of exactly how much energy they are displacing over time.

Let's review very quickly: you need to do some investment in additional aspects of analysis to make a project work under emissions trading. You need to start accounting for greenhouse benefits early on.

Emissions trading markets

There are two particular markets in emissions trading: the origination market in project finance, and a secondary market in commodity trading. Principally, I'm interested in discussing the origination market in project finance. There is a secondary market; I can go to brokers and get quotes on carbon right now. Last year, there were roughly $45 million to $50 million of actual secondary commodity trading in carbon units done in bilateral trades. It's highly risky at this point, but some people think they can spend a very low amount of money now and ultimately gain when this becomes a more fluid market.

Carbon provides another upside to development in renewable energy. The immediate need is to determine who owns the legal title. Legal title is extremely important; many times, we have had clients who have said "we have been doing a project, on the following things, and we would like to get carbon value out of this". We ask who in the original contract with the financiers and with the power purchase agreement owns the emission reduction. If the original contract does not state who owns the emission reduction, this creates problem.

You can do transactions for carbon financing separately, or you can do them with the main financing agreement. We see that the idea of stripping out the carbon value – either carbon allowances or credits – into separate finance vehicles is going to be a major area of growth. There is no need for carbon to particularly stick with the principal commodity and the principal production.

Currently, the carbon market, while growing rapidly, is bilateral non-liquid, and this limits the types of structures that are readily available. As we move into a more liquid market, the types of structures I'm going to talk about are going to become more real.

One area that we are particularly interested in is the use of carbon value to help facilitate debt guarantees. As we've heard several times, one of the major difficulties in smaller-scale renewable projects in particular is getting competitive price debt into those types of projects. If you can use early carbon value to help adjust that, and help purchase debt guarantees, there is a major potential that this value could facilitate.

Tapping the carbon market

There are two ways we see originators able to tap the carbon market. One is what we call a carbon purchase agreement. This is what we recommend to parties that are having difficulty getting their project financed at the outset. Essentially, they need a bit more money to put it over the top. It's the equivalent of a power purchase agreement in which the buyer and seller agree to a delivery schedule and price. It's a fairly low requirement – you don't need to know a lot about the whole process to do this. You're basicly selling at the up-front.

The second type is a merchant carbon producer, and I'll get to that soon. A carbon purchase agreement effectively means that you're selling a percentage of your volume of carbon over time. We've seen anywhere from 100% to 20% of the emission reductions being sold via a carbon purchase agreement. It's a contracted payment stream over time, and particular times have particular values. The values can be determined at the outset, or can be based on any number of external benchmarks. It's a slightly higher risk for the developer if you work off benchmarks – you don't get all your money up front. It may not be as bankable if you have a yearly payment based on performance. You're probably going to get a slightly better price, based on what we've seen from the market at this point. However, the counter-party and non-performance risks increase.

A new kind of transaction we've seen is called a merchant carbon plan. This is the equivalent of a merchant power plan in a deregulated environment. To make this happen, you need a liquid demand for carbon credit, or you need to assume that the liquid demand is going to emerge. Unlike electricity, you can actually bank credits over time, to wait for more favorable market conditions. If prices are low, you don't have to sell at that point – you can continue to accumulate and wait for the market to improve. If you need the money up-front, this is not the type of thing to get into, because you're basicly using your conventional financing to start the project, then you're capturing this as an upside between the project developers and the financiers. It requires pro-active market decisions. Basicly, whatever you decide to do with your carbon at this juncture should not impact what your financing structure should be at this point.

You clearly can separate your carbon value from this conventional part of a project. For example, you could have a power purchase agreement for the power plant, and a merchant carbon agreement for the carbon side. One does not define the other.

If you're going to get into the merchant situation, you need very active participation in the market. You need somebody tracking the carbon market, and you need somebody who understands where things are going and what they can be doing. There is no compelling reason that we can see for most renewable energy developers outside of somebody like Enron, for example, to rely on internal expertise to participate in this new commodity market.

The future of the carbon market

Academic research shows that this market should be worth between 5 and 25 dollars per ton by 2008. Once again, that uncertainty is extreme because of the uncertainty in the market. Current bilateral spot market – we're seeing between one to three dollars, depending on risk. You can see my slides on the website to determine what the risks are. The World Bank Protoype Carbon Fund is promising about five dollars a ton, but this is a fairly difficult thing to get into, and there is a fairly high barrier for entry of assets at this juncture. There are many opportunities for growth, yet there are many risks if you're unprepared.

Thank you.

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Demonstration of Renewable Energy Technologies in Developing Countries: The E7 Initiative

Michael Häder

Introduction

I want to use the time to tell you something about the engagement of E7 in renewable energy technologies, especially about one new project and a new financial concept we introduced there. We think it's a good model for future investments in renewable energy technologies in developing countries.

Origins and role of the E7

First of all, I have to tell you what E7 is. E7 was established in 1992 by some of the world's leading suppliers of energy services with the aim to foster concrete and real-life sustainable energy development. The "7" of E7 corresponds to the "G7", the club of the world's seven biggest economic powers. Today, we have got eight members in the E7 initiative. Three are from Europe; they are Electricite de France, Italian Enel, and RWE, the largest electric utility in Germany. There are three from North America; Hydro Quebec and Ontario Hydro from Canada, and Edison International from the United States. Last but not least, there are two Japanese companies - Kansai Electric Power Company and Tokyo Electric Power Company.

The common goal of the E7 initiative is to play an active role in protecting the global environment, and to promote efficient generation and use of electricity. We do it in a very special way that makes us unique compared with other organizations: we make available our expertise and many years of experience concerning a more efficient and lower-impact electricity supply and use in concrete projects and free of charge.

To reach this goal, E7 created the "E7 Network of Expertise". This network is aimed to improve co-operation between E7 members, and to act as an advisory board to electric utilities, governments, NGOs, and other partners. Furthermore it is the platform to develop concrete programs and to engage in corresponding projects.

Until now, we have distinguished between three different types of activities. The first is the network project, where E7 offers technical assistance to beneficiaries, such as to develop and operate reliable and environmentally sound power systems. We promote optimal primary energy use by making use of the fact that current E7 members show a great deal of diversity in their energy mix. And we foster customer energy efficiency by designing sophisticated tariff structures and by installing load management techniques.

The second type of activities is our human capability building program. This includes measures to improve the know-how in developing countries towards construction and management of sustainable energy systems. We do this by workshops and intensive training activities in these regions.

Last but not least, we lay main emphasis on concrete joint implementation projects. Currently, we have got three concrete projects in this area. One is placed in Zimbabwe, where we build a small hydro power station. The second one is in Jordan, where we are doing some retrofitting measures to improve the energy efficiency of some fossil-fueled generating units. The third is in Indonesia, where we are installing a mix of renewable energy systems. This is the project I want to tell you more about.

To date, we have got over a hundred projects that have been completed, or are still in action all over the world.

The work of E7 in Indonesia

The project we push forward in Indonesia has the purpose to supply a limited but reliable amount of electricity to households and community facilities through small autonomous electric systems. We are doing this in remote areas of the province of Nusa Tenggara Timur.

Several types of small autonomous systems have been installed there: two hundred sets of solar home systems, four micro hydro power plants with a total capacity of 140 kW, and one hybrid solar/wind system. The current status of this project is that the solar home systems have operated successfully during the past year, the four micro hydro systems are producing electricity for half a year, and the hybrid power system is just under implementation, and will be handed over possibly this month.

A second aim of the project is to reduce CO_2 emissions by about 30 000 tonnes over the period of the technical life of the system. Until the project was in force, the houses consumed fossil fuel-based energy, particularly kerosene and battery charging. By changing this to renewable energies, we did a significant deal to reduce CO_2 emissions. Another side effect is that the indoor quality could be improved, as fumes from kerosene lamps caused chronic aspiratory irritation.

The development of the project was done in close co-operation with the Indonesian government. The project is monitored and scientifically evaluated in accordance with the international climate protection regime. We want to establish it as a pilot phase AIJ project, with possible later certification as Mr Stuart told about.

The third project aim, and the one I want to tell you a bit more about, is that we tried to establish a self-financing concept, and even a self-management concept. We carried out a detailed socio-economic field study to findout about the ability and willingness to pay for electricity in this remote area. We therefore registered all types of incomes like salaries, wages, transfers, income from agro-forestry, and so on, and the expenses for energy by questoinnaire in different peripheral villages, some with and some without access to a grid. By comparing the data we determined a good indicator on evaluating the willingness to pay of inhabitants in the focused remote villages. In correspondence, and based on these estimates of willingness to pay, we developed an adaptive tariff system with two main parts: first, an initial down payment as a fee to join the club of users, and second per-annum rates with flexible payment modalities for the users.

We then established a co-operative for doing two main jobs. On one side, the cooperative has to guarantuee for the technical management. Therefore E7 trained the head of the co-operative in how to handle the service and to do the maintenance, particularly of the solar home systems. On the other side it has to establish a fund to cover the operating costs, and to build up a reserve for future re-investment in additional or substitute facilities.

I have to admit that the financing concept is not a truly self-financing one, as the initial capital costs are covered mainly by E7. The E7 initiative made a one-time kick-off investment, by giving the material, installation, and training to the people of this region. And we think that the project will work smoothly in future without any help from outside.

Project difficulties

While the project works well now, we had to overcome several difficulties in the past.

First, to get acceptance of the people to a new financing scheme that is more expensive to consumers than traditional development aid projects (where everything is for free) was a big problem. But we think that a "no free lunch" approach is much more betterfitting, as the financial responsibility of the users makes them care more about the system than if it was given free of charge. This is actually our experience after a year of operation: the SHS systems do work smoothly, and the people really do care for them.

A second difficulty to overcome was to make clear the sense of savings, and re-investment. It took much time to convince the people that it is necessary for them to put some money away so that the system will continue to work after the first solar home systems have expired.

Then, we had some normal problems with training and technical understanding.

A fourth problem was to manage logistics in these remote areas. Therefore, we started a one-man office to accompany the project during the pre-phase and the start-up.

And the acknolodgement as AIJ is still missing. We do have the acknolodgement of the German government, and we hope to get the same from Indonesia when we hand over the last hybrid power station this month. The project is put in the "Uniform Reporting Format" (URF) of UNFCCC so that final acknowledgement by UNFCCC could be given soon.

Lessons learned from work in Indonesia

We learned some important lessons from this project.

First, that government back-up is absolutely essential. E7 and the Indonesian government signed a memorandum of understanding in 1996, and E7 did all steps in very close co-operation with the Indonesian government to bring this project forward.

The second one is that tax issues like customs duties have to be clarified in advance, otherwise the investment could become a really expensive undertaking.

The third one is that the introduction of new project modalities, like new tariffs, require a really good concept on one side, and staying power on the other to get the acceptance of the people and of regional organizations. The involvement of local organizations is really recommended.

And finally, as stated, locally owned logistics are really necessary.

E7 put all these experiences into one feasibility study that will provide tested information and advice to interested banks, investors, local industry, and others. We hope that by this we can help new business opportunities based on renewable energy utilization in peripheral areas to do a good or even better job in future.

Many thanks for your attention.

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Session IV

Capacity Building

Awareness, Training and Quality Control - Technical Assistance for Market Development of Renewable Energy Technologies

Rolf Posorski

Introduction

Good morning ladies and gentlemen. I am pleased that so many of you attend this session on capacity building and framework conditions.

I have structured my presentation according to the following points:

- A brief summary of global trends and development goals and introduction of the key areas of BMZ promotion policy of renewable energies.
- Some examples will elaborate a little deeper the case of photovoltaics in Namibia.
- I will conclude the presentation, with lessons learned and the way forward as we see it.

Please note that all this information is available in the brochure titled , Renewable Energy for Sustainable Development and Climate Protection, Materials No 100 published by BMZ.

Global Trends and Development Goals

Economic progress and population growth will double the energy needs of the developing countries within the next 20 years. Apart from coal, the outlook of energy supply is that low-cost fuel reserves will be exhausted within a few decades. From the climate point of view, the message is that the release of greenhouse gases into the atmosphere must be reduced to tolerable levels. Therefore, the future rests on efforts to reduce energy consumption through more efficient technologies and to increase the use of renewable energies.

The trend of production capacity and sales reports of the wind- and solar industry look impressive. But a much higher rate of production and market expansion would be needed to meet the targets for reduced greenhouse gas emissions, or to curtail the growth of fossil fuel consumption.

As important as the reduction in CO_2-emissions is the strive for improvements in the developing countries' living conditions. This is true particularly in rural areas where large parts of the population have no access to commercial energy markets.

In light of the problems the German Ministry for Economic Co-operation and Development (BMZ), has formulated its priorities for promoting the use of renewable energy sources:

- Dissemination of RE-technologies in rural areas.
- Promotion of grid-connected RE-plants reducing the CO_2-emissions of the power sector.
- Measures focusing on the rational use of energy and the utilisation of renewable energy in urban areas.

These priorities are in line with the goals of other international conventions, namely the Rio Protocol 1992 and the Kyoto Protocol.

Down to earth - what can be done?

Some examples:

In rural areas, photovoltaic systems provide a cost-efficient basic electricity supply for lighting, water lifting and communication.

The key to a market-oriented dissemination of new technologies is the creation of appropriate framework conditions and a financing scheme for users and suppliers. (Example: Photovoltaics in Namibia).

Where fuelwood becomes scarce and expensive, the willingness of the population to accept alternatives tends to increase. This applies to more efficient stoves, biogas and solar cookers. (Example: Solar cookers in South Africa, biogas in Thailand and Nepal).

In many developing countries, energy sector reforms in conjunction with the removal of subsidies given to commercial energy helped to improve the competitiveness of renewable energies. In particular, this has increased the attention that electric utilities pay to wind energy within their expansion plans. (Examples: Wind park Brazil, Morocco, Namibia; mini hydro power in China/Tibet and Indonesia).

The Case of Photovoltaics in Namibia: A cost-efficient option for rural electricity supply

A priority of the National Development Plan of Namibia is the socio-economic upliftment of the rural population by improving their access to public services and infrastructure such as health care facilities, education, transport, water and energy. In view of this goal, the Ministry of Mines and Energy, supported by GTZ, has launched in 1993 a programme on the "Promotion of the Use of Renewable Energy Sources".

The approach of this programme was not to create a new implementation unit in the Ministry, but to integrate RE into existing structures, programmes and responsibilities. GTZ advisory focussed on two levels:

- support for sector policy in facilitating co-ordination, creating framework conditions and incentive schemes which allow commercial dissemination processes and stimulate technology transfer;
- information and advisory services for programme managers and market players.

In the case of Namibia, PV systems were introduced as cost-effective means of supplying electricity to health centres and schools and for supplying drinking water to remote areas. As a result the PV option is now integrated in the planning procedures of the Department of Water Affairs and the Ministry of Works. Since 1997 more than 50 health centers and schools were equipped with PV systems and more than 100 photovoltaic pumps were installed for rural drinking water supply.

But the real challenge is the supply of the private households with least cost electricity with SHS by a market-oriented dissemination approach. In the case of Namibia the strategy for SHS dissemination focused on 4 activities:

- increasing the awareness of the population by means of demonstration units installed at rural clinics and schools as well as by nation-wide campaigns in all public media,
- creating a countrywide installation and maintenance network by means of training local electricians, living in rural areas close to the potential customers
- establishing an appropriate credit scheme to provide loans to rural consumers willing to purchase a SHS.

Levelling the field for a price and quality competition and consumer protection: this means minimum technical requirements for SHS components had to be defined for dealers and suppliers that want to benefit from the financing scheme.

There is not much of innovative know-how required to implement the single activities, but the real challenge is to gear these and a few more activities in a concerted way. This approach has to organise several independent actors: hardware suppliers, providers of financial services, political level and last not least the customers. It makes, for example, no sense if a financing scheme is in place but this financing scheme suffers from high default rates caused by low quality products and non-existent after sales service.

So, the above outlined approach has successfully been tested in a pilot phase in Namibia, and it is now applied nation-wide. The credit scheme based on a Revolving Fund is administered by the Namibian Development Corporation, but it is intended to include commercial banks as well.

Namibia already has a number of local solar suppliers with good contacts to international manufacturers. Advisory services provided by GTZ helped launch the dissemination of PV in social infrastructure services (schools, health clinics), in rural water supply and in household applications.

Lessons learnt and the way forward

How can we accelerate the process of RE-technology dissemination? Shall we leave it to the market forces to grow with a sound pace in a competitive environment with practically no cost for society? Or shall we subsidise the access to energy and electricity of millions of people giving a boost to the industry, high economic burden for the society and the thread of follow up costs?

These questions illustrate we have practically left the phase of technical experiments and demonstration. The GTZ has, over the past 20 years, implemented approx. 150 projects in more than 30 countries to investigate sustainable concepts for rural electrification. We have learnt that much attention should be given to influencing the political and economic framework conditions and to supporting market forces in order to trigger market growth. It is obvious that significant impacts can only be achieved through large-scale dissemination efforts with tens of thousands of decentralised systems. This highlights the importance of a viable RE industry (manufacturers, suppliers and service providers).

So, besides conducive framework conditions, a co-operation of the policy level with key players in business and industry is required; a kind of public-private partnership that helps convert the demand for energy services into a sustainable marketplace.

Where is the way forward? I would like to draw your attention to the following points:

- A growing number of developing countries have recognised that RE-technologies are a cost efficient tool for improving the quality of life in rural areas. A good number of countries are ready to level the playing field for a market oriented dissemination of RE-technologies.
- BMZ is ready to support these efforts with a substantial contribution of 200 million DM annually.
- The international know-how allows to approach large scale dissemination projects. Institutions familiar with technical assistance like GTZ or international training like CDG can prepare and facilitate the implementation by providing advisory services, co-ordinate communication between the players and accompany the technology transfer.

The achievements of the Wind- and PV- industry including many specialized smaller companies are recognised world wide. In particular, the technical maturity of products improved and prices dropped significantly during the last decade. A growing number of companies are ready to engage themselves in market development and technology transfer in developing countries.

And last not least: There are a number of internationally recognised R&D-institutes especially in Germany with intensive links to the industry, that are good candidates to support technology- and know-how transfer.

Ladies and Gentlemen, the preconditions for large scale dissemination of RE-technologies have never been better than today. Large scale dissemination is essential to

- attract the support from the political level
- cut down specific transfer costs for preparing and establishing dissemination structures
- provide a critical mass to allow suppliers and industry to invest in marketing and after sales service.

In a joint effort with our partner counties, the institutions of development cooperation and the engagement of the industry it will be possible to transform the need for energy services in rural areas into a sustainable market for renewable energy technologies.

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Capacity Building in African, Caribbean and Pacific Countries - A joint UNDP/EU Initiative

Anthony Derrick

Introduction

"Energy as a tool for sustainable development" was a joint study of the EU and the UNDP. The editor of the report was Prof. Ugo Farinelli. The study is based upon widespread consultation with individuals and organisations throughout the Africa, the Caribbean and Pacific states and two workshops were held to review the various key issues. (In the back of the report, the full contact details, including e-mail addresses of all the authors and reviewers are provided for purposes of correspondence).

Scope and objectives

The chapter co-ordination was done by two groups, One group dealt with small island states, for which IT Power was coordinator. The Sub-Saharan Africa chapter was co-ordinated by the Stockholm Environment Institute.

The objectives of the report were to serve as a guide on the main issues concerning energy, environment, development, finance, energy policy, and development co-operation. The report was reviewed not only by key people within the African, Carribiean and Pacific states, but also by members of the development community and the bilateral agencies of the European union member countries such as Britain, Germany, Spain, France, etc.

Conclusions of the study for Small-Island states

IT Power looked particularly at the small-island developing states, the so-called SIDS in those key regions. These countries, of course, are quite diverse. A place like Kiribati, with just a few thousand people scattered over a huge ocean area and a very low GDP per capita is quite different to Jamaica, which has high electrification already.

The total population of the ACP small islands is only around 9 million. They have limited land availability, and of course, around 50% of the population of these small islands live within 2 km of the sea. Other general characteristics of the Islands are that they are isolated from mainlands, in remote large ocean areas, environmentally vulnerable, and vulnerable to climatic change. It is unfortunate that the small islands of the ACP are most at risk from climate change, and yet they are insignificant contributors to the causes of climate change.

Other key general characteristics are that they have limited financial reserves, and limited infrastructure, often because of the small populations and small, fragile economies.

Key energy sectors in many Islands States are transport and tourism.

The emerging visions of this study are concerns over

- environmental consequences of present energy policies
- level of rural accessibility to energy services
- vulnerability of states to external petroleum, economic, and political shocks

- increasing energy consumption,
- inefficient energy use, and
- lack of adequate schemes of cost recovery of energy production costs

The future of renewable energies in Small Island states

One of the key challenges in utilizing renewable energy in small island states is overcoming some disappointing past results arising from lack of appropriate project planning, insufficient participatory planning with users and inappropriate institutional set ups.

The need to put sustainable energy into the non-energy sectors (health, water supply, agriculture and fisheries etc..) development, was a key conclusion of the study. Hence a recommendation for more integrated planning was high on the study's recommendations.

The conclusions of the study represent the views of many organizations and individuals from the African, Carribiean, and Pacific states. These conclusions and recommendations included a need for participatory project implementation and effective project monitoring and evaluation.

The study concluded that capacity-building and developing integrated energy policy are key future requirements. Integrated energy planning is achieved by looking at energy in terms of security, access, diversification, reduction in costs, environmental and political targets, sustainable energy technologies, technology leapfrogging, and energy for rural development, poverty alleviation, etc. These are key areas where capacity has to be built up within institutions to further these aspects.

Other priority areas, the study concluded, were

- reforming energy prices, taxes, and subsidies to create a level playing field. Supporting innovative financing mechanisms for renewable energy and energy efficiency is necessary, along with activities to encourage greater participation of the financial sectors.
- updating the institutional, legislative, and regulatory environment to create an enabling environment
- Providing information through activities such as developing "master plans",
- ensuring we look at renewable energy and energy efficiency in the non-energy sectors.

The study believes the principal capacity-building requirements are in:

- technical resource assessment, technology choice, etc.
- Integrated energy planning, and master plans.

We need to build up capacity in these sectors.

Good project management is key to good project implementation, therefore further capacity building in this area was highlighted.

Some capacity-building activities should be enterprise-focused as well as government and NGO focussed. For example, providing training to photovoltaic companies to ensure sustainable businesses and energy service companies is key, as is providing training to financial institutions to develop confidence for lending on renewable energy projects.

Some examples of building capacity through project design are the EU regional solar pumping program, which did a lot for building capacity in water delivery services and equipment maintenance of renewable energy. The "Financing of Energy Services for small-scale Energy users", (FINESSE) in the Philippines, where support is being given to the Development Bank of Philippines to help identify and fund bankable renewable energy projects is another example. The GEF/IFC PV Market Transformation Initiative is providing financial, managerial and technical training to enterprises that are receiving investment under the GEF-IFC PV MTI.

Again, we believe enterprise focus is important. Quality assurance strategies are vital. For example, in the Photovoltaic PVMTI, we're ensuring that when we make investments into companies in India, Kenya, Morocco, only where those companies have a clear quality assurance strategy.

Human resource management is often not greatly understood within some enterprises. Training and keeping staff is important. Management training should include accounting, administration, and business planning. To use as an example the recent EU call for proposals on PV systems for use in Kiribati in the Pacific, one of the key personnel required for that project under technical assistance is a business management expert, providing accounting and administration support to the PV companies.

Conclusion

So, in conclusion, the study promotes

- integrated energy planning
- master plans
- enterprise-focused activities
- support to financial institutions in capacity building
- building capacity through project design

The report is available through the EU and UNDP missions throughout the world.

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Integrating Cleaner Solutions in Energy Market Development: The Role of the Carl Duisberg Gesellschaft (CDG)

Klaus Knecht

General Role of CDG

The Carl Duisberg Gesellschaft is a non-profit organization dedicated to international training and human resource development. The organization was founded in 1949. To date there have been more than 250,000 participants, many of whom are influential decision makers around the world. With more than 200 development programmes under the motto "Training for Sustainable Development" CDG qualifies executives and junior managers from developing countries to contribute actively to the creation of a sustainable future. By doing so, CDG promotes economically and ecologically sustainable development processes in order to enhance the international competitiveness of developing countries and to improve the living conditions for broad sectors of society. CDG receives about DM 51 million of programme funds from the German Federal Ministry for Economic Co-operation and Development (BMZ) and additional funds of about DM 10 million. CDG co-operates closely with those representatives of the German industry who are either producers or users of environmentally sound technologies. CDG's headquarters are located in Cologne. The expert group for programmes to protect the environment and conserve natural resources is located in Berlin; the author is part of this group.

CDG Intervention Areas

CDG is committed to the principle of sustainable development and thus also to sustainable energy supply. In the field of renewables, this means:

a that CDG provides energy policy decision makers from developing countries with a forum in which to deliberate ways to shape political and economic conditions, and to learn from others' experience of making provisions and laws and using market-based instruments to steer the actors in liberalized energy markets in the direction of sustainable energy supply. CDG thus creates a forum in which the essential reformulation of government energy policy can be prepared, in readiness for implementing more sustainable energy supply structures. a that CDG gives private and public utilities and independent power producers (IPPs) in developing countries an insight into the radically evolving structure of German utilities and provides information on operator models. In future, localized supply solutions will not be restricted to small-scale CHP (combined heat and power) or CHCP (combined heating, cooling and power generation - 'trigeneration'), but will increasingly be based on hybrid systems, i.e. on the use of a range of renewable energy technologies. The development and deployment of fuel cells for electricity and heat generation is of central importance to decisions made on whether to extend electrification primarily via large-scale supply networks or to take a more localized approach. The new strategy of one major German electricity corporation, which plans to make increasing localized use of this technology and assume a more substantial role as an energy service company (ESCO), may well signal the way forward for developing countries. Moreover, CDG is also intent on contributing to sustainable organization of distribution structures and to the development and production of renewable energy systems in developing countries, and consequently works actively on the necessary technology transfer, focusing both on technology and on the marketing and PR aspects. a Putting CDG strategy into practice in the civil society sector means that the CDG training programmes use the knowledge of experts from political and scientific establishments in the industrialized countries to communicate the steps necessary to overcome political constraints, and to educate participants on specialist issues. CDG hopes to be able to contribute to greater cooperation between representatives from industry, government and civil society in the target countries on sustainable energy supply.

CDG's Didactic Concept

Together with its partners, CDG investigates which problems most urgently need to be solved in relation to more sustainable energy supply or more widespread use of renewables in a country or a region. Then both sides enquire into the most suitable target groups to solve these problems and the needs of these partners (target groups) in terms of acquiring information and experience (learning objectives) before they can implement and sustain solutions to the problems. Next, CDG seeks those experts, either in the region or from Germany or elsewhere in the world, who are best suited to communicate the requisite expertise.

In this role, experts must increasingly have the capacity to conceive and carry though a training programme that measures up to the intercultural and interdisciplinary demands and the personal experiences of the learning community to which participants belong. Specialist expertise and management expertise (content) needs to be taught with equal standing. The integration of institutional partners has a structure-building effect, while working together with other partners in development cooperation and with international organizations and regional networks exploits synergy effects.

Probably the most important component of the didactic concept is precise definition of target groups and selection of the right participants from these target groups.

The main target group for CDG training projects in the field of renewables are managers who can play an executive role in carrying through more sustainable energy supply in their own countries. They may come from the public sector or from industry, but could equally be key representatives of civil society. They must be open to different alternative solutions, have the capacity to learn, and be willing to gain personal experience of cooperation in interdisciplinary working groups of international composition. They must be capable of making decisions based on specialist and management expertise, having assessed objectives and impacts comprehensively. With this in mind, they must be prepared to acquire advanced skills for action and decision-making. They must be prepared to take leadership in processes of change; they must also be competent and motivated to shape such processes of change.

CDG organizes such international learning communities and carries out training programmes in a range of learning contexts, both in project regions and in Germany. The value of this type of training results largely from cooperating in working groups during the training course and learning by sharing experience with people from different regions and diverse disciplines. In other words, CDG does not provide (initial) training but advanced training focused on practice and problem-solving, addressed to executives and multipliers who are in a position to make strides towards more sustainable energy supply and to expand the use of renewable sources of energy. Individuals and groups within society who exert a significant influence in reforming their society in line with principles of sustainability are both partners and target groups for our training programmes.

CDG uses the following methods: seminars, workshops, including group work and solving practice tasks or developing projects in working groups which may be intercultural and interdisciplinary in composition; study trips, including visits to see practical applications, on the one hand, and production facilities for renewable energy components or systems, on the other. CDG facilitates participation in international symposiums and conferences, delivers specialist theoretical training courses of several months' duration, as well as practical placements with manufacturers of renewable energy systems, in development and planning offices, in utilities, institutions of applied research and in insurance and operator companies.

Programmes of up to 12 month's duration are intended to train junior managers as project managers for renewable energy projects. The managers will then be competent to initiate and prepare projects, monitor project planning and ensure full implementation. In the wind power sector, for instance, this includes initiating reliable wind measurement procedures and evaluation, selecting prime locations, compiling wind potential studies, making viability projections, producing financial plans, supervising construction design and execution, etc. These programmes combine a specialist theoretical element with practical advanced training, and conclude with a one-month management-training course.

Projects lasting several years take various guises and include diverse training content. They are addressed to all the key stakeholders, e.g. energy planners, utilities, ESCOS, producers and importers of components and systems, potential financiers, energy policy makers, but also the media and the insurance industry. In these projects, CDG delivers training in presentation skills, moderation skills, and management and leadership skills. Above and beyond this, CDG introduces the participants to role-play methodology, uses application software and practices working with intercultural groups. Increasing use of teletraining is scheduled, particularly for follow-up work.

With this type of project which relates closely to practice in industry, CDG is working towards the long-term objective that, given skilled training from CDG, from other institutions of international cooperation and from industry, local experts will be enabled to take over the maintenance and service of renewable energy systems and develop and implement marketing and PR strategies to achieve swift market introduction and enduring market penetration. CDG would also like to contribute to linking companies from developed economies with cooperation partners in the South who will produce high-grade components and eventually also systems under licence. If the political and economic conditions in a region are advantageous for renewable energy systems and there are skilled (technology and management) experts on the ground, the chances of success in establishing joint ventures or subsidiary companies in countries of the South will much improved. Development partnership between private industry and energy policy is supported by CDG wherever both parties feel committed to the principle of sustainable management and are pursuing a joint route towards the implementation of more environmentally sound energy supply. The same applies to cooperation between industry and governments in industrialized countries and developing countries.

Public-private partnerships in Germany may present a good model for equivalent partnership arrangements in developing countries. This could increase the likelihood of political measures to create conditions that will encourage greater use of renewables. By cooperating with industry, industrial experience of applications can be used to benefit partner countries in the South. These countries may share directly in technical progress through their involvement in joint training projects. Furthermore, cooperation with advanced companies from the North which are committed to sustainable development may be perceived by companies from the South as an incentive to imitate them (assuming a role model function).

Critics of this attitude are urged to consider that unless industry starts thinking and acting sustainably, there can be no sustainable development. This is why international learning communities, as described above, specifically and deliberately include decision makers from German industry.

Addressing Burning Issues Holistically: Integrating Cleaner Solutions in Energy Market Development

I would like to focus on three major developments in the energy market to demonstrate how CDG's advanced training programmes and didactic concept address the changes in this area.

State

Liberalisation and Deregulation

The liberalisation and deregulation of the **energy market** leads firstly to the dissolution of the state monopoly on generating, transmitting and distributing power.

The second step involves introducing new state regulations to control the energy market indirectly.

Consequences

Cities, regions and the country as a whole lose their direct decision-making power with regard to investments. They are no longer responsible for operating utilities.

There is a way out of the state-supported, sometimes inefficient electrification system, which often helped to throw these countries into even worse domestic and international debt. Resources mobilised as a result can be used for promotion policies in keeping with the market and adapted to the needs of market players and international funding agencies (e.g. for a decentralised renewable energy supply for regional areas).

CDG's involvement

CDG provides a platform for those responsible for energy policy from countries of the South to discuss how to restructure the energy market and weigh up the possibilities for creating the political and economic framework conditions which this necessarily entails. CDG passes on experience gained in developing and implementing laws, regulations (network access, supply fees, transit charges) and market-compatible instruments (charge per ton of CO_2 or the authorisation of emission trading) aimed at controlling liberalised energy markets with the goal of creating a sustained energy supply.

Private enterprises

Liberalisation and Deregulation

Private enterprises are mainly active in the **energy generation** sector, but are also involved in **transmission and distribution** in some countries.

Consequences

Profit considerations are a top priority in all privatised companies. Any enterprise competing with others on the open market is forced by cost considerations to take steps to increase efficiency in power stations and transmission networks.

CDG's involvement

Increased efficiency results in reductions in the consumption of resources and consequently in CO_2 emissions (also in the conventional energy sector). CDG conducts advanced training projects to increase efficiency in power stations and also among energy consumers in industry and the service sector (Peru, Costa Rica, Brazil).

Liberalisation and Deregulation

In more and more countries independent companies are **producing energy** and **obtaining authorisation as energy providers**.

Consequences

Small enterprises in particular can produce energy in locations with high renewable energy potential and either feed this into the general network or operate small separate island networks. RE systems can also be employed economically to alleviate expensive peak load periods.

CDG's involvement

In Africa, Asia and Latin America CDG conducts management seminars covering topics such as bankable business plans, financing, insurance issues, PR and marketing, and workshops on technical problems. These programmes are aimed at small and medium-sized enterprises producing and marketing renewable energy systems and components or providing energy services.

Liberalisation and Deregulation

The liberalisation of energy markets also opens new doors to **direct investment from abroad**.

Consequences

This makes the latest and most efficient conversion technology for energy production widely available.

CDG's involvement

CDG supports the flow of information on the latest technology and new management strategies between developing countries and the developed world by organising study trips or business meetings.

Liberalisation and Deregulation

Liberalisation has resulted, at least sometimes, in a significant **reduction in energy prices**.

Consequences

This is due to the abolition of state price monopolies and increasing competition pressure, along with efficiency-boosting measures in the areas of production and transmission. This goes hand in hand with workforce cuts. Prices are now often set solely according to the marginal cost principle, i.e. according to the cost of generating an additional kW·h. Investment costs and external costs (e.g. for the environment) are not included in these market prices.

CDG's involvement

During its seminars and workshops CDG debates with political decision-makers and business leaders about the consequences of ignoring external costs. In addition, we provide information on financing possibilities for more environmentally friendly energy solutions. We convey practical information on the efficiency-boosting potential of improved technology and offer advanced training courses on quality management.

Liberalisation and Deregulation

Opening the energy markets **accelerates technical progress** in the areas of renewable energy and highly efficient technologies, encouraging the production of such systems.

Consequences

This includes massive increases in generator efficiency (in wind power generators from 100 kW to 1,500 kW with state-of-the-art technology) within a few years; production expansion in the photovoltaic area; development of new production lines (CIS thin-layer cells, a planned annual production of 1.2 MW), to list just a few examples.

Technical advancement is particularly noticeable among "conventional", decentralised energy technology (combined heat and cooling power plants). Marked improvements in efficiency and environmental protection also accompany the implementation of innovative gas technologies.

CDG's involvement

CDG informs participants in its advanced training programmes about these new developments. CDG cooperates closely with the Central Employment Agency to organise several months of advanced training in Germany and work experience in key companies in this sector for programme participants.

CDG also gives its advanced training guests intensive exposure to new technologies (e.g. fuel cell technology) and encourages experts from the developing countries to become actively involved in the further development of future-oriented technology.

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Standards for Quality and Safety of PV-Systems

Wolfgang Wiesner

Environmental Impact of SH-Systems

The deployment of small home supply systems (Solar Home Systems), which in particular serve to provide the basic supply of energy for lighting, is an excellent example which shows the energetic superiority of a photovoltaic system with regard to climate protection. A SH-system should be defined here as a photovoltaic system which consists of a PV-generator with only a few PV-modules, which in total have a output of 25 up to a maximum of 150 Watts. This output should be sufficient in order to ensure the basic requirements of a family regarding the supply of energy. Essentially these requirements comprise lighting and communication, but maybe also in the future such systems could secure a better and more hygienic supply of foodstuffs.

Figure 1 shows the principal set-up and construction of a SH-system and figure 2 its deployment in Indonesia.

If new energy systems are considered under power economy aspects, then the examination of the energy balance should always result via the examination of the service life. Particularly with photovoltaics particular importance is placed on this so-called cumulated energy expenditure. Whereas with regard to the electricity generated as the final energy a photovoltaic module today still requires approx. 5 years in order to be superior to a coal power station with regard to its CO_2-emissions, the same module requires only approximately 7 months in order to generate the same service "light" with a SH-system with less CO_2-emissions than with a kerosene lamp as figure 3 shows.

For the potential user in the rural regions of the third world these advantages are not an argument for deciding in favour of a SH-system. We must be realistic and recognise that these people who often have great difficulty ensuring that their families are provided with their daily food supply, do not know this impact to global climate and for them climate

It would also make no sense to try to teach them to appreciate this problem, as they would immediately and justifiably confront us with the argument that the climatic problems have been caused through the emissions of the industrial countries. Consequently if SH-systems are to be bought by these people then these systems must be an economic alternative and also mean an increase in comfort. The increase in comfort with regard to the quality of the light is obvious and must not be substantiated point for point. Also the fact that the generation of light results without any emissions that create any olfactory nuisance whatsoever is immediately clear.

Economical impact

Nevertheless the market introduction of SH-systems proves to be difficult as the economic prerequisites are evidently not subjectively fulfilled.

If a calculation of the economic efficiency is made with the methods which are customary for us, table 1 shows that SHS are close to the break even point. The prices for kerosene which are thereby presumed are the world market prices. In many countries, however, this fuel is subsidised for social-political reasons, and therefore a microeconomic examination for the individual household in the third world often leads to contrary results. From a political economic point of view the question then arises as why a Solar Home-System is not subsidised by the government to the same extent as kerosene. The answer lies in most cases in the lack of solvency of the countries and this applies naturally all the more to the private households.

World-wide programs for rural electrification

For these reasons in many countries in the third world programmes have been launched, some of which are highly extensive and as a rule are supported by industrial countries or by international organisations financed by

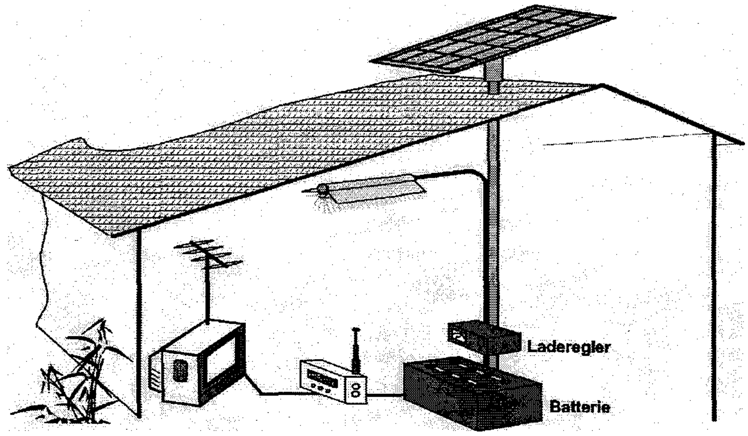

Figure 1: Principle description of a SH-System

Figure 2: SH-system on home of a PV-dealer

the industrial countries, which are intended to lead to the introduction of SH-systems. An example of this is the 1.000.000 Roofs Programme in Indonesia, which is financed by the World Bank for 200.000. The development of suitable finance instruments in the microeconomic sector is reported elsewhere. The examinations and considerations are however insofar of importance at this point, because the service life of the systems directly influences the economic efficiency through the depreciation derived accordingly.

The main task is therefore to design and to construct SH-systems in such a manner that they comply with the prerequisites of long ser-

	Kerosinlampe	SHS-System
Monthly costs on basis of local prices	2,57 DM/m	
Monthly costs on world market prices	9,00 DM/m	9,47 DM/m

Table 1: Comparison of prices

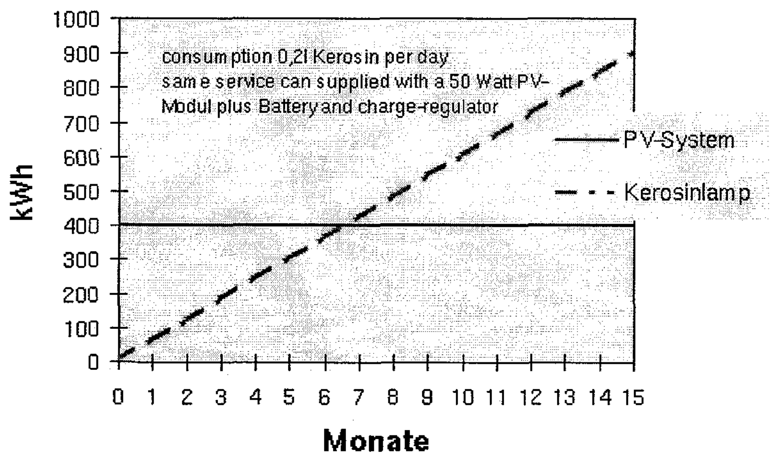

Figure 3: Cumulated energy consumption protection is a question of no importance

vice life and naturally also of efficiency, without any considerable increase in their price as a consequence.

Requirements concerning quality for Solar-Home-Systems

As SH-systems are principally of simple design and construction, many components can easily be manufactured by small companies in local manufacturing companies. Only the PV-modules must be bought in. In individual cases the trial manufacture of these modules has already commenced. This is naturally a highly desirable development. The main problem thereby is that the SH-systems, which fundamentally are technically very simple are subjected to a number of forms of environmental stress as is shown by figure 4, which is to be taken into account through corresponding constructive measures as a rule in the qualitative sector. In no way should the creativity and good will of the small companies mentioned be disputed. However, long-term experience and discipline are necessary in order to implement the necessary quality procedures during construction and production. As this experience is often lacking qualitatively inferior products of short service life were often placed on the market in the past. An under-dimensioned diode then leads to the total failure of the system. In this case the principle is particularly true that the weakest link in the chain determines the overall load capacity. The whole SH-system and consequently also the photovoltaics are disqualified through imperfect technology. Consequently this plays into the hands of the critics who do not think that it is correct that photovoltaics should particularly be introduced into the markets of the poorest people in the poorest countries.

The question therefore arises as to how this problem can be solved. How and which experience can be passed on from the industrial nations in order to solve this obvious quality problem without destroying the existing commercial structures and without establishing an excessive structure of controls.

Worldwide operating systems for Quality assessment

The classical instruments deployed by industrial societies to solve these problems are standards and quality certificates which affirm the conformity of the products to these standards. Corresponding acceptance of these quality symbols is now to be created by the state or by corresponding educational campaigns. The CE-symbol, for example, is a state prescribed prerequisite for placing products on the market whereas other symbols have gained market importance as a result of competence or through the aims set by the certifying organisations and consequently

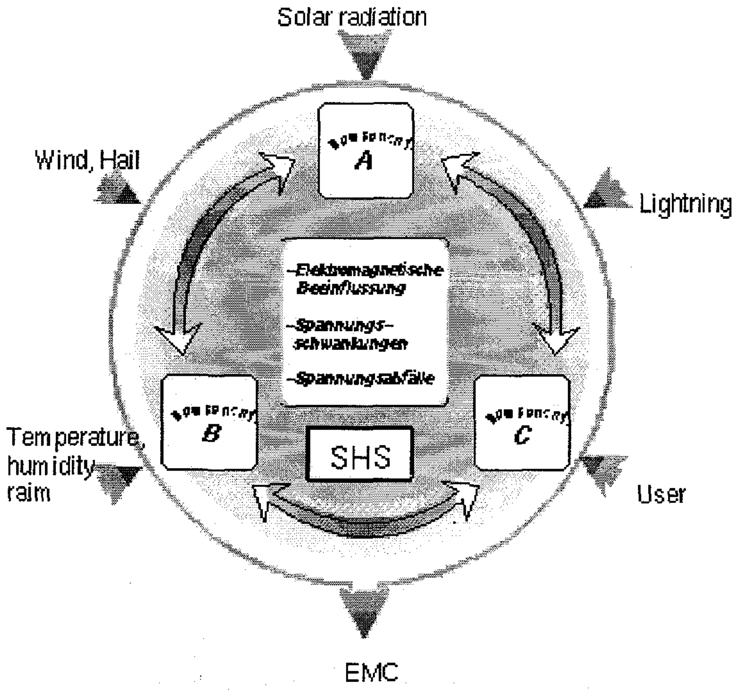

Figure 4: Environmental Impact on SH-Systems

have a regulative influence. Examples here are the so-called "blaue Engel (blue angel)" or , for example, the symbols of TÜV, UL or DIN.

Quality regulation and guidance through state prescribed certification systems incorporates the fundamental risk that it will be misused as market segregation. Consequently then national standards are developed which may then possibly only be used by nationally recognised or state-like certification organisations. The corresponding state directives then make placing the products on the market dependant on these certificates. This risk can only be countermanded through the internationalisation of standards and through a reciprocal recognition of certification systems. The World Trade Organisation (WTO) is making efforts to establish such generally recognised structures.

At an international level the standards of the International Electrotechnical Commission (IEC) and the International Standard Organisation (ISO) are a suitable basis for this system. Product requirements and prerequisites are now as a rule stipulated in the classical standards. In the past 10 years also system standards have become available which describe the organisational framework conditions for producers and service companies, not only in order to secure quality during production, but also to create complete quality assurance systems including certification systems. The most well-known directives are summarised in the ISO 9000 series. So-called ISO/IEC guides attempt to standardise the set-up and construction and the mode of operation of certification systems and test laboratories. The standards described here are already widely accepted. As a result of corresponding contracts between the European standards organisations CEN and CENELEC and ISO respectively IEC the standards of these organisations will also continue to adapt further. This process is not as advanced in other regions such as in the USA and Japan. Continuous efforts are required with order to also incorporate new actors on the world market, such as for example China.

The range of influence of certification systems is naturally much smaller. The CE-symbol is on the whole only of importance within Europe. In addition there are private certificates which by all means are of supraregional importance, for example the

Figure 5: Outdoor Test Facility

TÜV-symbol and the UL-symbol. But even with these examples one cannot speak of international recognition. The so-called GAP-system was brought into being in order to overcome these drawbacks particularly for the small photovoltaic system sector. IEC has established an own system based on the existing structure of the test organisations for electrotechnology in the individual member countries. This certification system called IECQ is to date only of importance on the market for electronic components. Its certification procedures are consequently also orientated towards the structure of this market. It is obvious that considerable efforts are required in order to establish such an internationally recognised system like the GAP system quasi "out of the blue". The initiators of the GAP-system have recognised this fact and have made use of the operative support of IECQ. One problem of this construction lies at present in the fact that this system does not submit to the contracts of reciprocal recognition as is stipulated by the WTO in GATT. This system has also at present not been accredited by a national accreditation organisation which reciprocally recognises standards within so-called multilateral agreements. The

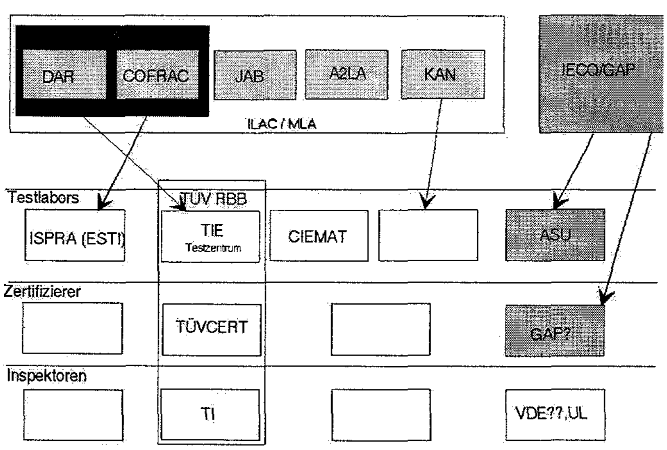

Figure 6: Structure of international certification systems

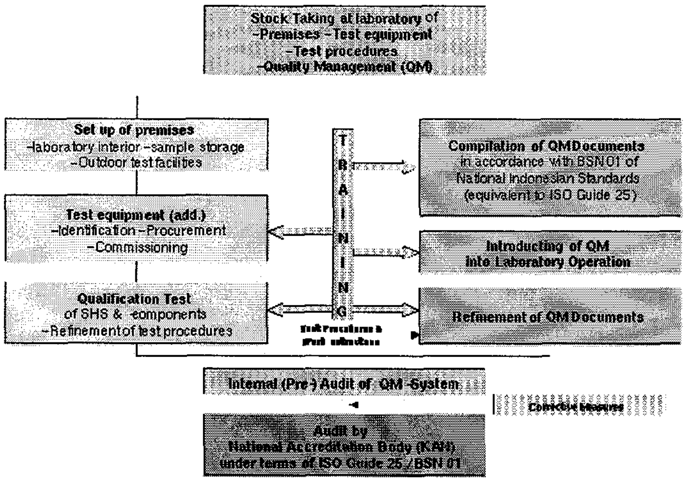

Figure 7: Structure of SHS-Project Indonesia

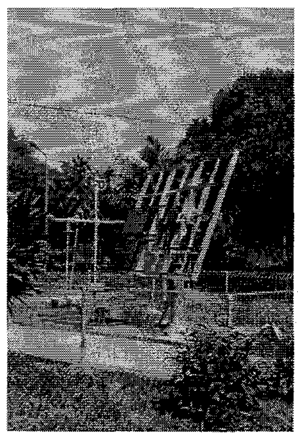

Figure 8: Tracker

following picture shows the rough structures of this situation.

Let us now return to the question posed at the beginning as to how these international systems which serve as quality assurance, can be deployed in order to improve the situation on the SH-system market. The depiction so far does not exactly give any encouragement to carry on in this manner. But this is the correct path. The path of new and accordingly certainly national systems is definitely the more unfavourable solution.

Accordingly the support of the previous actors is required in order to deploy this system also for the third world and for the PV-systems market. Hereby a dual strategy must be developed which on the one hand establishes suitable structures in the target countries through training measures and through material support. On the other hand the international standards and certification systems must be adapted to this development. Corresponding projects have already been set up.

Introduction for Quality assessment systems for Solar-Home-Systems in Indonesia

One example of this is the support given by TÜV-Rheinland/Berlin Brandenburg for the establishment of a test laboratory for photovoltaic components in Indonesia, which should be qualified to such an extent that

Figure 9: Test facility for SH-Systems

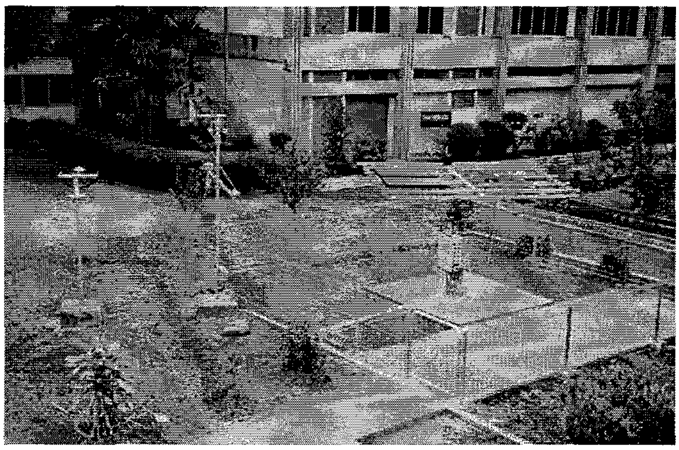

Figure 10: Test stand for batteries

it can be accredited as a test laboratory for the relevant standards by the national accreditation organisation. This project has been supported by the World Bank and the Federal Government of Germany. Furthermore the Australian government has provided considerable funding for the material infrastructure. The accreditation system GAP has developed various internal standards which fill the gaps in international standards. Now it is the task, particularly of the national test laboratories, within the framework of product certification, to carry out guidance towards reliable products with a long service life through a co-operative supervision of the development. Furthermore it will be necessary to carry out basic work through training measures, particularly in the technical colleges and universities whether within the third world countries or through exchange programmes in the industrial countries.

The plan in figure 7 shows the structure of the project in Indonesia. We work together with well-trained, qualified colleagues. The technical prerequisites are fulfilled through corresponding laboratory setups as are shown in the following picture. The quality assurance handbook is based on the long-term experience of the Test Centre for Energy Technology at TÜV Rheinland, which has been accredited by the DAR (German accreditation council) as a test laboratory for PV

Table 2: Abreviations used in this document

A2LA	American Association for Laboratory Accreditation
ASU	Arizona States University
CIEMAT	Centro de Investigaciones Energèticas Madioambientales y Tecnolígicas
COFRAC	French Committee for Accreditation
DAR	Deutscher Akkreditierungsrat
EA	European co- operation of Accreditation
ESTI	European Solar Test Institute
GAP	Global Approval Program
IECQ	Qualitätsprogramm der Internationalen Elektrotechnischen Kommission
JAB	The Japan Accreditation Board of Conformity Assessment
KAN	Indonesian National Accreditation Body
TIE	TV Rheinland Immissionsschutz und Energiesysteme GmbH
TVCERT	TV Zertifizierungsgesellschaft
TVRBB	TV Rheinland/Berlin-Brandenburg
UL	Underwriters Laboratories
VDE	Verein deutscher Elektrotechniker

systems. We presume that the LSDE in Indonesia will achieve accreditation in the summer through the national Indonesian accreditation organisation. Then the market conditions will have to decide whether this laboratory can be accredited as a test laboratory for the GAP-system, or whether it will work together with a local certification system and establish a certification system made to measure for SH-systems as is described in the current draft of the IEC-Standard 62078. This system would then however presumably not rise above national importance.

Obviously training and qualification measures for development and production engineers and also for fitters, electricians and maintenance personnel must be carried out parallel to the establishment of these quality assurance systems.

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Cross-Disciplinary Programmes: Wind Energy in the State of Ceará

Alexandre Rocha Filgueiras

CDG and the Wind Energy in Ceará

Carl Duisberg Gesellschaft (CDG) is a non-profit organization whose objective is the training and development of human resources in developing countries. CDG has been promoting technical courses and the administration of projects in wind energy that facilitate technology transfer and the initiation of industries which produce components or complete units to capture wind energy.

The modern history of the wind energy in Ceará began with a partnership between Germany and Ceará, with the support of various German institutions. This partnership began in 1992, when an agreement between COELCE and GTZ was established to measure winds in Ceará. In the same year, the Federal University of Ceará, COELCE and the group J. Macedo from Ceará, signed an agreement to purchase materials for wind measurement and CDG, through the German Institute of Energy Eílica (DEWI), promoted a lecture on wind energy which was presented by DEWI.

The lecture introduced a specialized course on wind turbines connected to the grid. This was the beginning of the participation of the Federal University of Ceará (UFC) in the area of the wind energy, which designated a technician to take this course. Subsequently the Department of the Electric Engineering of UFC began to participate in forums of national and international scope on wind energy.

In the First National Encounter about Wind Energy in 1995 in Minas Gerais, a representative of this department participated in the work group on teaching wind energy. One of the measures adopted by this group was that they should impliment courses on renewable energy in universities, particularly on wind energy.

As a result of this introduction and the subsequent interest in wind energy at this university, other exchange activities began to appear. The first was a successful application to the Technical University of Berlin, which requested they provide an apprenticeship of three months to facilitate, as part of a cultural exchange, the research for a student's final course. His work involved the development of profiles of blades for small wind turbines.

Two other apprenticeships were obtained for students at the University of Kassel in Kalsruhe. These students were also developing their final projects, this time in the area of solar energy which was being used for purifying chlorine for treatment of water for human consumption. These apprenticeships initiated a new research program and a partnership between UFC and the University of Kassel.

Today an experimental station for purification of water exists in a municipal district close to Fortaleza. This station, besides providing a benefit to the local population, also facilitates technology change in the treatment of water for the human consumption. As well, it helps in the training of students from UFC.

Training Programme on Wind Energy

As part of a training program of the wind energy in Brazil and Argentina, promoted and coordinated by CDG, UFC participated in a project in Argentina. Here, global planning was initiated for the development of wind energy in Brazil ang in Argentina.

Course of Wind Energy in Fortaleza

Planning for the development of wind energy in Fortaleza was accomplished by March 27 and on April 14 a course for technicians was held on wind energy. The course was offered to technicians from a variety of companies, both private and state-owned and from several Brazilian states. The objective of the course was to provide training in the areas of techniques of wind measurement and the function and use of the computational program WAsP. The course was therefore divided in two modules: the first involving techniques of wind measurement, where had a theoretical and a practical component, and the second module involving the use of the program WAsP.

The theoretical component of the first module emphasised the requirement for care necessary in taking wind measurements, since they are decisive factors in the calculation of the return of the investment in a wind energy project. The second component consisted of the assembly of a 10m tower for measurement, which put the theoretical concepts into practice. This was useful for the the second module where the functions of WAsP were first presented, then followed by comparisons of the predictions of wind energy production from WAsP with data collected using the measurement tower set up in the first module. A visit to a meteorological station also provided an opportunity to assess the measurement of the measurement tower.

Course of wind energy at the Federal University of Ceará

At the Federal University of Ceará, soon after the Seminar of Belo Horizonte - MG, a graduate course on wind energy was introduced as recommended by the seminar. The basic content followed the orientation of the material of the course promoted by CDG in DEWI. This " new " subject proved extremely popular among students, some of whom were later contracted by Wobben Wind Power and completed their studies with specific courses in Germany. The graduate course includes the following subjects: Historical Evolution of Wind Energy; Wind Potential; Use of Wind Potential; System of Conversion; Electric Machines; Economic Aspects and Modeling of Systems.

Nowadays we have a group that works with wind energy, including three lecturers who research wind energy at UFC. This group is studying the rural electrification of small farms using wind energy and, together with the University of Kassel, they are also reserching the use of solar energy in the purification of water.

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Cross-Disciplinary Training Programmes: A Basic Course on Wind Energy

Maria R. Pereira De Aráujo and Miguel Hiroo Hirata

Introduction

The objective of this consists in a preparation of a basic course on the use of the wind energy. The purpose of the basic course is to introduce the basic concepts on the use of the wind energy. It is assumed that this course will give the basic knowledge on wind energy for the professionals that will permit then to attend the advanced courses on this subject. This course is one of the topics in a co-operation between CDG - Carl Duisberg Gesellschaft and institutions in Brazil and Argentina.

Basic course on the use of wind energy

Activities to develop the basic course on the use of wind energy

The preparation of the basic course on the use of the wind energy, was based on the following premises:

1. The purpose of the basic course is to introduce the basic concepts on the use of the wind energy for professionals, as detailed in the item 3: Topics to be taught in the Basic Course, of part 2 of this document.

2. This course is applied to the technical professionals that works or intend to work in applications of wind energy. These professionals must be graduated, preferably in Mechanical or Electrical Engineering, and to have basic skills on computation.

3. Portuguese will be the language of the course.

4. The support material, in Portuguese, will be supplied to the students.

5. The basic material, in Portuguese, will be supplied to the instructor.

It is assumed that this course will give the basic knowledge on wind energy for the professionals that will permit them to attend advanced courses on this subject. The following activities are proposed to elaborate the necessary material for the "Basic Course on Use of the Wind Energy":

Activity 1: To conduct a survey to find out available courses in the area of wind energy. The main items of this research are:

- Institutions where the courses are offered;
- Level of the courses (graduation, master's degree, extension);
- Content of the courses (when this information is available);
- Frequency in which the courses are offered;
- Persons in charge of the courses.

Activity 2: To search for Institutions where the basic course, and other courses, about wind energy could be offered.

Activity 3:The identification of the topics that should be taught in the basic course:

- The identification of major topics;
- The identification of sub-topics.

n.b. The topics and sub-topics found during this activity should be considered as references for the preparation of the course, but eventual changes, for example the inclusion of new topics, may occur during this process.

Activity 4: The choice of the methodology to be used in the preparation and presentation of the "Basic Course on Use of the Wind Energy". This activity should provide information about the following items:

- Type and characteristics of the support material for the students.
- Type and characteristics of the support material for the instructor.
- Specification of the facilities to be used by the instructor.
- Specification of the facilities necessary to the students.

Activity 5: The presentation and the description of different alternatives to offer the courses. Few examples of these alternatives are:

- The instructor travel to the place of the course or the students travel to the place of the course;
- The course will be only given in one presentation for a long period of time or it will be given in several presentations for short period of time each.

Activity 6: The preparation of the schedule of the activities.

Activity 7: The preparation of the material for the course.

Topics to be taught in the basic course

The proposal of topics to be approached in the basic course is shown bellow. This is an initial proposal and small modifications may be introduced during the preparation. These modifications, however, should not introduce radical changes in the initial planning; they should be seen as adjustments.

1. Use of Wind Energy
   (a) The wind as one of the manifestations of solar energy
   (b) Use of wind energy through the times
   (c) The potential of the use of wind energy
   (d) Winds and other sources of energy
2. Wind Systems and Hybrid Systems
   (a) General description of a wind system
   (b) General description of a hybrid system
   (c) Components of a wind system
   (d) Flow of energy in a wind system
3. The Winds
   (a) Origins and mechanisms: global and local circulation.
   (b) The development of the earth boundary layer
   (c) Geographical accidents that alter the distribution of the winds
   (d) Measures of wind speed
4. The Description of Wind Potential
   (a) Analysis of the measured data
   (b) measures of central tendency
   (c) dispersion measures
   (d) distribution of speeds: histogram
   (e) other types of distribution
   (f) Wind speed as a random variable
   (g) Statistical inference
   (h) An introduction to Wasp and the correlation analysis
5. Operation of Wind Systems
   (a) Types of control of wind systems
   (b) pitch control
   (c) stall control
   (d) Ways of operation of wind systems
   (e) constant speed
   (f) variable speed
   (g) Assembling rotor-generator
   (h) Calculation of the energy
   (i) flow of energy in function of the machine and of the wind potential
   (j) use of available software (Alwin, Hybrid II, or other)

6. Wind Rotors
    (a) Types of wind rotors
    (b) Analysis of the operation principles
    (c) slow rotors: drag force
    (d) fast rotors: lift force
    (e) Global analysis of wind rotors (Theory of external field)
    (f) Betz limit
    (g) operation mode.
7. Horizontal Axis Wind Rotor
    (a) Geometry of horizontal axis rotors
    (b) Theory of blade element (Theory of the internal field)
    (c) Merging theory of the external field with the one of the internal field
    (d) The graphics of performance
8. Vertical Axis Wind Rotor
    (a) Savonius Rotor
    (b) principles of operation
    (c) graphics of performance
    (d) use
    (e) Darrieus Rotor
    (f) operation principles
    (g) graphics of performance
    (h) use

Methodology used in the preparation of the material

Preparation of Material for the Course (Basic Text).

This text should contain the whole material described in the topics of the previous item. The text should, in the future, develop into a basic book on the use of the wind energy. It is important to observe, however, that the material of this basic text will be collected and developed for use during the course as described below.

Preparation of the Material for the Instructor.

The material to be used by the instructor should consist of "slides" containing illustrations, short texts, equations and tables. These "slides" will be prepared with "power point" software in a way that can be used with animation. Besides the "slides" some software can be supplied for the calculation of some parameters and they can be used in classroom. If available, films and photos will be placed at the instructor disposal.

Preparation of the Material for the Students

The material to be used by the students will consist of copies of the "slides" accompanied of short texts explaining the main points. This material will be printed. The computer programs mentioned in the material for the instructor will also be supplied to the students.

Basic Facilities for the Instructor

As was described above, the Instructor will need a basic computational infrastructure:

- Personal computer equipped with CD-ROM or with Zip Driver;
- Overhead projector or slide projector;
- Projector screen.

Basic Facility for the Students

- personal computer for each group of three students.

Schedule

Next it is presented the schedule for the activities that should be undertaken, during the year 2000, for the preparation and presentation of the Basic Course on Use of the Wind Energy, detailed in table 1:

1. The survey of the courses that are offered in the area of wind energy.
2. The identification of Institutions where the basic course and other courses of wind energy could be offered.
3. Identification of topics that should be approached in the basic course.
4. The choice of the methodology to be used in the preparation and presentation of the basic course.
5. The presentation and description of different alternatives to offer the course.

Activity	Trimester 1	Trimester 2	Trimester 3	Trimester 4
1	X	x		
2	X	x		
3	X	x		
4	X	x	X	
5		x	x	
6.1		x	x	
6.2			x	x
6.3			x	x
7				x

Table 1: Planned activites for preparation and presentation of the course

6. The preparation of the material for the basic course.
   (a) The collection of material to write a basic course.
   (b) The preparation of the material for the instructor.
   (c) The preparation of the material for the students.
7. The preparation of an outline of the presentation about the Basic Course on Use of the Wind Energy.

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CEP: 37500-000

Annex I: Institutions that offer courses about wind energy found during the research
1. Universidade Federal do Rio de Janeiro - UFRJ (Federal University of Rio de Janeiro) Mechanical Engineering Department - Wind Energy and Aerodynamics Laboratory

- Level: graduation, masters degree extension
- Content of the course (when possible)

The wind and its characteristics; Wind systems; Hybrid systems; Wind potential; Operation of systems of conversion of wind energy; Control of wind energy conversion systems; Costs of wind energy conversion systems.
Frequency in with the course is offered

- regularly offered 1 time a year
- offered when there is demand

- Person responsible for the course.

- (Gustavo Bodstein); Ph.D.

(Professor responsible for the Laboratory) telephone: e.mail: gustavo@serv.com.ufrj.br
(Maria Regina Arajo); D. Sc. (Professor of this course) telephone: (21) 541-7831 e.mail: regina@serv.com.ufrj.br

2. Universidade Federal da Paraíba - UFPB (Federal University of Paraíba) Mechanical Engineering Department - Group of Energy - Level: graduation, masters degree and extension - Content of the course: The wind and its characteristics; access to wind energy - wind turbines; systems of conversion of wind energy; wind energy conversion systems control; matching wind turbine with the wind; economy of wind energy conversion systems. - Frequency of the course:

- regularly offered once a year
- offered when there is demand

- Person responsible for the course.

- (Francisco José Simes); PhD

(Responsible professor for NERG - Group of Energy) telephone: (83) 333-1000 extension 358 fax: (83) 333-1650 e.mail: fjsimoes@nutecnet.com.br

3. Universidade Federal de Minas Gerais - UFMG (Federal University of Minas Gerais) Department of Electrical Engineering - DEE - Level: graduation , masters degree extension - Content of the course (when possible) Course: " Conversion of Renewable Energy " The course has two units, being Unit I: Systems of Conversion of Energy and Unit II: Systems of Conversion of Wind Energy, whose content is presented below. Unit II: characterisation of wind energy; wind turbines; engineering of conversion systems of wind energy; electric generation system of variable speed; electric generators and devices of static conversion; studies of cases, isolated applications and connected to the electric network. - Frequency in which the course is offered

- regularly offered once a year
- offered when there is demand

- Person responsible for the course.

- (Selênio Rocha Whistles); title Dr. Eng.

(Professor of DEE) telephone: (31) 499-4842 fax: (31) 499-4810 e.mail: selenio@cpdee.ufmg.br

- (Pedro Francisco Donoso Garcia)

(Professor of DELT/UFMG) telephone: (31) 499-4842 fax: (31) 499-4810 e.mail:

4. Universidade Federal de Pernambuco - UFPE (Federal University of Pernambuco) Department of Mechanical Engineering - Level: graduation masters degree extension - Content of the course: In this university a master of sciences course is offered on wind energy and the following subjects are studied: Characteristics of the Wind; Advanced Wind Engineering; Aerodynamics; Wind Energy Conversion Machines; Pump Systems Technology; Hybrid Systems Wind/Solar/Diesel; Renewable Energy; Special Topics in Wind Energy I; Special Topics in Wind Energy II. - Frequency in which the course is offered

- regularly offered x times a year
- offered when there is demand

- Person responsible for the course.

- (Everaldo Feitosa); PhD

(responsible for the Test Centre of Wind Turbine) telephone: (81)453-2975 fax: (81) 271-0359 e.mail: windcenter@npd.ufpe.br

5. Universidade Federal Fluminense - UFF (Federal University Fluminense) Department of Electrical Engineering - Level: graduation masters degree extension - Content of the course (when possible) - Content of the course: Introduction to wind energy, Wind characteristics, Wind energy conversion systems, Economic considerations, Research on wind energy. - Frequency in which the course is offered

- regularly offered x times a year
- offered when there is demand

- Responsible for the course. (Geraldo Tavares); DSc. (Professor of the Electrical Engineering Department) telephone: (21) 620-7070 extension 309 fax: (21) 717-4446 e.mail: ecowind@telecom.uff.br

Annex II Institutions where the basic course could be offered

1. Universidade Federal do Rio de Janeiro - UFRJ (Federal University of Rio de Janeiro) Person responsible for the course: (Gustavo Bodstein); title PhD (Professor of the Department of Mechanical Engineering) telephone: (21) 562-8406 fax: (21) 290-6626 e.mail: gustavo@serv.com.ufrj.br

2. Universidade Federal do Ceará - UFC (Federal University of Ceará) Person responsible for the course: (Alexandre Filgueiras); title PhD (Professor of the Department of Electrical Engineering) telephone: (85) 248-0088 fax: e.mail: filgueiras@secrel.com.br

3. Universidade Federal do Pará - UFPA (Federal University of Pará) - Person responsible for the course. (João Tavares Pinho); PhD (Responsible for GEDAE - Group of Energy) telephone: (91) 211-1977 fax: (91) 211-1299 e.mail: jtpinho@ufpa.br

4. Universidade Federal do Rio Grande do Norte - UFRN (Federal University of Rio Grande do Norte) Person responsible for the course: (Zenaide Alves Arajo); title PhD (Professor of the Department of Mechanical Engineering) telephone: (84) 215-1634 fax: e.mail: zenaide@ct.ufrn.br

5. Universidade Federal do Rio Grande do Sul - UFRGS (Federal University of Rio Grande do Sul) Person responsible for the course: (Adriane Prisco Petry); MSc (Professor of the Mechanical Engineering Department) telephone: (51) 316-3931 fax: (51) 216-3196 e.mail: adrianep@vortex.ufrgs.br

North-Rhine Westphalia - Your Partner in Research, Development, and Training in the Field of Renewable Energy Sources.

Karl Schultheis

Introduction

North Rhine-Westphalia is Germany's number one energy state, accounting for 90% of hard coal and 50% of brown coal mining, 33% of generated electricity and 40% of industrial energy consumption.

With the "solar factory", one of the world's largest production facilities for photo-voltaic cells has been built here in Gelsenkirchen. More than a million people are employed in the energy sector in North Rhine-Westphalia. Changes in the energy supply structures therefore deserve acute attention. At Kyoto, the industrialised nations untertook to make contributions also to short-term reduction of greenhouse gases in the atmosphere. Scenarios coming from various sources over the past years underscore the fact that, beyond those undertakings, it will be possible to boost to 50% the share of renewable energies in worldwide energy supply, and to cut fossil energies back to today's share.

I won't omit that there are other scenarios going much further. As early as ten years ago, the North Rhine-Westphalia Government started to act on those developments by launching a range of action programmes funding development, production and marketing of renewable energies and energy saving schemes. Those programmes falling under the jurisdiction of more than one government department were grouped together as the so-called Future Energies State Initiative, providing a common platform for debate and action in education, science and business.

In this Initiative, the Ministry of Schools, Education, Science and Research is the leading agency for research, development and training in the field of renewable energy sources and energy saving. Nowhere in Europe are higher education and research facilities set as closely as in North Rhine-Westphalia. The state therefore has a solid competence base when it comes to dealing with the wide variety and crossdisciplinary character of those issues. We have grouped together the assisted R&D activities in the Solar Task Force (AG Solar NRW), a research and technology network with currently 150 members, among them the assisted institutions.

Other institutions active in the fields described above are free to join the network as well. They are invited to visit the joint stand in the Science Park's foyer and receive information about the Future Energies State Initiative and AG Solar.

AG Solar

Let me present AG Solar's activities and link up with the issue of using sources of renewable energy in countries in the sun belt. AG Solar covers these sectors:

- photovoltaics
- thermal systems
- energy technologies for sun-belt countries
- low-energy building and solar architecture
- solar chemistry and solar materials research
- sustainable materials and energy management

AG Solar is turning ten next year. Since it was set up, the Ministry has supplied some 110 million deutschmarks to fund 180 or so projects. For the results, visit the Task Force's website at http://www.ag-solar.de.

Projects

Today's issues are all related to the use of renewable energies in sun-belt countries.

Dr Wiesner, of TÜV Rheinland, has just outlined the activities, funded by AG Solar, on modular and photovoltaic system qualification. Release of insufficiently tested systems for rugged application in tropical areas is essential to the development of a new technology which has yet to be fully acknowledged. We therefore back the TÜV's activities in the international standardisation bodies because we want to see the use of properly trialled high-quality methods only. At the same time, we do not want to see such bodies abused to promote individual interests of countries or organisations who could use standards and qualification requirements to hinder or altogether cut off free access to markets or national and international programmes.

Under the heading, "Energy technologies for countries in the sun belt", let me direct your attention to Aachen Polytechnic's Solar Institute at Jülich which is particularly active in that sector, maintaining a range of international contacts and running various projects, including C.A.R.E., the Centre for the Application of Renewable Energies on the Greek island of Crete.

The centre is due to expand its activities to decentralised electricity supply, utility water treatment, agriculture and training. We are using C.A.R.E. as a presentation centre for solar plants and their construction and installation. Moreover, it serves as a "bridgehead" for Southeastern Europe and North Africa, and as multiplier and clearing house for experiences gathered from the construction and running of the hybrid facilities.

It goes without saying that solar chemistry and solar materials research are poised to provide solutions for sunny regions. Chemical processes requiring the light of powerful lamps or heat can also be triggered or accelerated by light or heat from the sun.

Under the auspices of the AG Solar, we have set up an experimental facility at the German Aerospace Centre (DLR) in Cologne. This "sun furnace" permits 5000-times concentration of sunlight, and temperatures in excess of 2000 degrees centigrade. The sun furnace is used, among other things, for materials research such as stresses caused by rapid temperature fluctuations under atmospheric conditions, aluminium recycling or UV testing of lacquers.

Water treatment processes are being tested in concave "grooved" collectors. The first demonstration plants will shortly be set up, involving specialist firms. Flatbed reactors are well suited for production of certain fine chemicals for the plastics, medicine and perfumes industries. We would be very much interested in applying the technology in a sun-rich country as interested industries could then be practically guaranteed a positive production result.

Let me particularly point out the huge energy savings made possible by utilising solar energy for the cooling of buildings. In sun-rich countries, it would have an extra advantage to use solar-powered air conditioning, on account of the converging supply and demand figures. The question crops up on a regular basis whether it is photovoltaic or solar-thermal cooling that is cheaper to run. Actually, it is primarily a building's architecture well suited to the local climate which makes additional cooling unnecessary. More specifically, the use of shading, avoiding flat roofs, using glass, within reason and where appropriate, and locally tried building materials. There are many more options.

This goes not only for building in sun-rich countries but for Germany as well where of course more attention must be paid to aspects of heat insulation. Regrettably, nowadays sun-rich countries tend to copy the building styles of the northern industrialised countries, entailing greater needs for air conditioning and energy.

In the meantime, awareness is increasing in many sun-belt countries and efforts are being made to return to the advantages of traditional building styles. It is an exciting task to combine the knowledge optimised over generations of architects with ideas developed here in North Rhine-Westphalia, for example at Dortmund University's "Climatically Sustainable Architecture Department", or to use customised software to sound out what is possible. I am sure there will be synergies enabling buildings to be designed with the aid of modern software while using existing know-how and traditional materials for construction.

At AG Solar, we have had great success with simulation software tailored to the needs of small architect's or engineering firms that cannot afford more complex programs. We would very much welcome some sort of cooperation in this field.

A case in point is a program for installing ground heat exchangers, pipes in the ground feeding outside air into the building. Due to the storage capability of the soil in combination with the slow rate of heat release, the air is precooled during the summer and preheated during the winter. Conventional air-conditioning and heating systems can therefore be kept smaller, dramatically reducing the amount of energy needed.

By using a ground heat exchanger in a building complex on the "Solar Campus" at Jülich, we were able to altogether dispense with traditional air conditioning. Buildings belonging to the complex include residential units and university premises built according to various energy standards. The project is designed to demonstrate the various options of low energy construction, solar architecture and modern heating and a/c technology, gather experience and pass it on.

In another regard, too, the Solar Campus is a role model for AG Solar, by familiarising students with the requirements, overall conditions and the options for energy-saving construction. At the same time, the students live and work in those buildings, experiencing at first hand both the good points and drawbacks. What I have just said highlights one of my Department's crucial objectives, the integrated education-policy aspect of AG Solar. It is the end users who, through their behaviour, control an essential element of energy consumption. Responsible energy use behaviour cannot be expected without first explaining context, causes and effects. We have to inform about the existing potential of renewable energies and the rational use of energy. Students in particular are important addressees since during their career, all of them are bound to have to deal, in some form or another, with the issue of energy use and its costs.

The transfer of know-how is crucial not only within a country but also across national borders. Which is why we are delighted that the Jülich Solar Institute, building on their work in the AG Solar, has been asked by the Carl Duisberg Society to act as "expert" hosts for scientists, engineers and decision makers from developing and newly industrialising countries visiting Germany. Under a comprehensive programme involving various highly competent institutions, the visitors will be familiarised with the potential of renewable energy sources and the rational use of energy . We regard the professional and personal contacts developed during the one-year visit as essential to succesful transfer of know-how. Such transfer is not a one-way street from North to South. In Germany, we have got to learn where the problems are and which overall conditions a solution must meet in order to satisfy the technological requirements and, above all, have the necessary credibility.

Ladies and gentlemen, It takes a free back-and-forth flow of information and knowledge to solve the crucial problem of how to reconcile worldwide energy supply at reasonable prices with shrinking supplies of primary energies and a rapidly increasing world population. I am here to encourage you totake your ideas and your queries to AG Solar and the Future Energies State Initiative. To find solutions, we must join forces. Thank you for your attention.

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Invited Contributions

Global Approval Programme for Photovoltaics

Peter Varadi

Introduction

The introduction of the utilization of Renewable Energy (RE) to developing Countries is challenging. Several of the sessions in this meeting are addressing one or other segment of this challenge. A very positive aspect is that RE technology was sufficiently developed, but in spite of the developed technology, its deployment in Developing Countries is unfortunately plagued with failures. This paper will focus primarily on issues related to Photovoltaic (PV) Systems.

Background

Photovoltaic (PV) components and systems used for terrestrial generation of electricity are produced in very many countries but with very uneven quality. The simplest PV systems consist of the PV module, which generates the electricity, battery, charge controller or inverter, light and also switches, wires connectors. Consumers in developing and in developed countries use these systems. Unfortunately there are a number of documented failures1. The PV Industry will rise or fall based on the quality of the PV products.

The externalization of quality control is becoming the way of life in the industrialized countries. It is not the best business practice, but it is cheaper to eliminate quality control in manufacturing and let the consumer find out if the product works. The consumer can return the faulty product and it will be replaced. Unfortunately this option does not exist for PV in Developing Countries. To sell non-working PV products or systems to the poorest people on earth, where in most cases the product they can afford to buy provides only about 50 W hours per day, where the return option does not exist, is a crime.

The reasons for the failures are:

- For many components, except for the module, and for installation of the simplest PV systems are no international standards available.
- Lack of accredited PV testing labs (at present there are only 3, one in the USA and two in Europe)
- No quality assurance system existed.

Global Approval Program for PV (PV GAP)

PV systems are proven to be very reliable if produced with quality. The failures occurring especially in developing countries alarmed donor organizations and also the PV industry. To ensure the quality of PV systems, these stakeholders created PV GAP.

PV GAP's Mission Statement

PV GAP, a not-for-profit international organization, is dedicated to the sustained growth of global photovoltaics (PV) markets to meet energy needs worldwide in an environmentally sound manner. Our mission is to promote and encourage the use of internationally accepted standards, quality management processes and organizational training in the design, fabrication, installation, sales and service of PV systems. To this end, we partner with PV and related industries, international organizations, testing laboratories, government agencies, financing institutions, non-governmental organizations, and

Figure 1: PV GAP "Quality Mark" for PV Components for PV Systems

Figure 2: PV GAP "Quality Seal" for PV Components for PV Systems

private foundations, in developing and developed countries.

The strategy of PV GAP is to

- establish a PV Quality Mark for components and a PV Quality Seal for systems (Fig. 1 and 2 to facilitate easy recognition of quality PV products and to differentiate them from products of unknown quality
- provide reciprocity globally, which means that PV components and systems having the Mark and/or Seal should be accepted globally and not required to be re-tested.

PV GAP will license suppliers of PV products to use the registered PV GAP Quality Mark for components and Quality Seal for systems. The Mark and/or Seal will be licensed[1] if the produced PV components or systems

1. were manufactured in a quality manufacturing process (ISO 9000),
2. were manufactured according to international standards of the International Electrotechnical Commission (IEC), or, if not available, according to the PV GAP Recommended Specifications (PVRS),
3. were type-tested by a Testing Laboratory accredited to PV under ISO/IEC Guide 17025 and
4. are continuously monitored by the IEC Quality Assurance System (IECQ).

Quality Manufacturing of PV Components and Systems

Today, the globally accepted system for a quality management of the manufacturing process is the ISO 9000 standard. It is generic and, therefore, is used in many industries. At present, a few PV manufacturers meet the ISO 9000 standard, but many do not. Of the latter, many simply may not know about the standard, but others think that the ISO 9000

[1]PV GAP Reference Manual; Reference number: PV GAP 01:1998

system is too technical and expensive to be practical for small and medium-size companies to implement.

Recognizing that this is a valid concern and that the original ISO 9000 documentation was far from user-friendly, PV GAP has developed a Training Manual[2] to spell out in simple terms what is required by the ISO 9000 standard and to provide forms that PV companies can reference to easily and inexpensively install a quality manufacturing management system without having to hire an extensive staff.

Standards

Technical

Technical Standards: PV GAP promotes global utilization of the International Electrotechnical Commission (IEC) PV standards. Where no IEC standards cover particular PV products or quality assurance, the PV GAP Technical Committee4 (which has open, worldwide membership) develops interim Recommended Specifications (PVRS). The PVRS draw on existing procedures and practices (for example utilizing proven National PV Standards). PV GAP submits each new PVRS for consideration and approval to the IEC TC 82 Technical Committee for PV products.

Certifiable

Certifiable Standards: The difference between the Technical Standard and the Certifiable Standard (Blank Detail Specification - BDS) is, that the technical standard deals with the testing procedures, while the BDS is specific for each manufacturer and provides information about the structural equivalency of product, so only one type has to be tested and also details the need when the product has to be re-tested.

Testing Laboratories and Reciprocity

PV GAP relies on IECQ-accredited PV product-testing laboratories, which are ISO Guide 17025 approved. The importance that an accredited Testing Laboratory should do the test is that this provides global reciprocity, which means that the products will be accepted in all of the countries and have not to be re-tested, This reduces the cost of the products. A list of such laboratories is available from PV GAP's Web site (www.pvgap.org).

Continuos auditing and surveillance

The purpose of auditing and surveillance is to encourage and ensure the adherence to the standards. This system is used in many industries and it was decided that PV GAP should not invent a new approval system, but use an existing internationally accepted approval process. The International Electrotechnical Commission Quality Assessment System for Electronic Components (IECQ) was selected because:

- IECQ is a well-established and globally accepted approval program
- The IECQ system is relatively simple.
- The IECQ system assures reciprocity; this means that a product manufactured and tested in one country or area need not be re-tested in another country or region
- It is an inexpensive system and will not burden the PV industry unduly.

The IECQ system is based on many "supervising inspectorates" (SIs) located all over the world. The supervising inspectorates are the organizations responsible for surveillance that the manufacturer's ISO 9000 certification is valid, that the test was successfully conducted in an accredited Testing Laboratory and that the stipulations of the BDS are correctly and timely maintained.

Using a uniform criteria the SIs are approved by IECQ's "Inspectorate Co-ordination Committee". This assures unified rules and standards and, most importantly, reciprocity within the system.

The elements of the PV GAP approval process is shown on Fig. 3

International Cooperation

Members of the PV GAP Executive and Advisory Boards represent national and regional

[2]Quality Management in Photovoltaics - Manufacturing Quality Control Training Manual. Prepared for the World Bank by PV GAP (PV GAP - February 2000: Reference Number QM 1.0)PV GAP Reference Manual; Reference number: PV GAP 01:1998

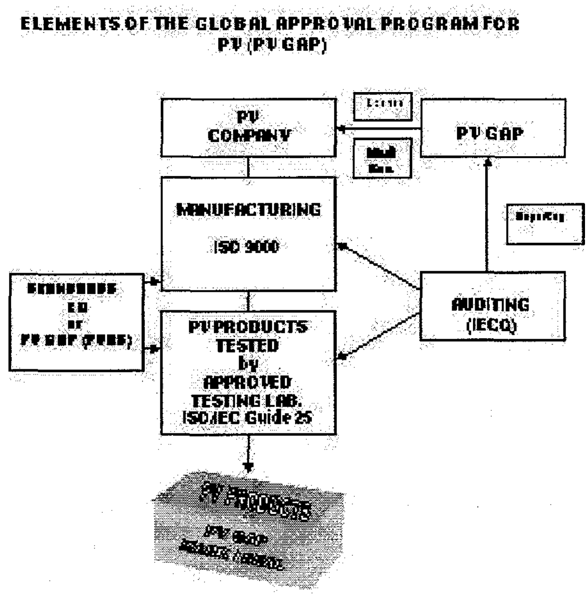

Figure 3: PV GAP approval process

solar energy industry associations and testing laboratories, multilateral funding organizations, international energy organizations and the IECQ. The Executive and Advisory Boards of PV GAP also include PV experts from industry and government organizations in industrialized and developing countries. PV GAP has its headquarters in Geneva, Switzerland, as does the IEC. The procedures of PV GAP are aligned with those of the IEC/IECQ.

Stakeholder Benefits

End users

End users, purchasing PV products with the PV GAP Quality Mark and Seal, are assured that products have been designed, tested, produced and approved according to internationally-accepted IEC standards or PVRS and are subject to on-going product-quality auditing under the IECQ.

Suppliers

Suppliers, using the PV GAP Quality Mark/Seal, "level the playing field" by inducing marginal suppliers to bring their products in line with one set of performance standards. Reciprocity arrangements, within a worldwide network of accredited testing laboratories, eliminate the delays and costs involved in multiple testing of PV products in national markets.

Governments

Governments or large-scale developers of national infrastructure, can specify the PV GAP Quality Mark/Seal when issuing tenders for PV products with local or imported content to assure uniform product performance.

Financial Institutions

Banks, multilateral lenders and foundations that finance PV products with the PV GAP Quality Mark/Seal can rely on the technical quality of such products.

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50 Solar Energy Estates in North Rhine-Westphalia

Dagmar Everding

Solar Energy Estates in North-Rhine Westphalia

In North Rhine Westphalia, almost 18 million people live in an area of 34.000 square kilometres. North Rhine Westphalia is known for its industrial regions with coal mines and steel works. Since fourty years there is an intensitive structural changing. In the meantime sings change can clearly be seen in the cities: technologie centres, solar production, big solar powers, low energy housings and solar architecture.

In 1997, four minstries (Economics, Urban Development, Research and Construction) together jointly launched the campaign for the construction of 50 solar energy estates in Northrhine Westphalia. For this ambitious project, the state initiative "Future Energies" established an office in the Ministry for Construction and Housing to take care of the applicants.

The four ministries campaign formulates specific requirements for the construction of solar energy estates:

- Passive solar construction.

60% of the energy consumption specified under the 1995 thermal isolation regulation is to be saved: At present houses need 10 litres of oil for one square metre in the year.

- Production of hot water.

Solar energy has to contribute at least 60% of the energy required.

- Consumption of electricity.

At least 1/3 of the average annual electricity needs are to be covered by solar energy.

At least two of the requirements are to be fulfilled in order to obtain the status of a "Solar Energy Eststate in Planning.

In addition, a planning manual places further requirements to integrate the estate into a comprehensive concept. Among other things this relates to:

- the integration of the estate in a location utility service,
- ecological requirements, such as the use of appropriate building materials,
- traffic requirements, such as links with the local public transport system.

A commission of experts examinates the proposals of the cities wishing to take part. The cities look for areas, optimize urban planning for solar energy use and define the energy concept of the housing projects. Urban planning is optimized by a special software, which is made available to city administrations by the ministry for urban development

Until now 15 estates were awarded the status "Solar Estate in Planning". Two solar estates have just been completed: Steinfurt und Gelsenkirchen-Bismarck. Further estates are already under construction.

Solar estate Steinfurt

To be erected in the Borghorst quarter of the town of Steinfurt is the first solar housing development with centralized solar hot water supply. In conjunction with an underground thermal storage unit (using gravel and water) about 45% of heating and hot water demand is covered by harvesting the suns energy. Features of this development: 48 housing units, energy-conserving, passive solar construction, centralized solar collection heating system, 550m of collector area, longterm heat storage unit.

Solar estate Gelsenkirchen

The first housing development in the Ruhr Region to fully exploit solar potential is coming into being in the bismarck quarter of Gelsenkirchen. Both masonry and frame homes will be built. In addition to autonomous, house-by-house energy supplies, energy transfer points at terminal stations will also be used for groups of homes. Features of the development: 72 housing units, annual hesting requirements 40 to 60% below specifications in the Thermal Isolation Code, solar collection covers 65% of warm water demand (440 m of solar collectors), photovoltaic units cover 40% of power demand; installed output: 88 kWp, installation of gas lines for cooking purposes, rainwater percolation.

Results and conclusions

The project "50 Solar Energy Housing Estates" is also a big process of learning. Planning and realizing the first estates we will get much new knowledge, which we want to use in the following projects:

1. Solar urban planning must not concentrate in positioning houses toward the south. On one hand attractive urban spaces need flexibly positioned houses. On the other hand deviations from orientation to the south makes solar houses very expensive. Solar urban planning has to find out the optimized figures for urban designing and eficient solar solutions

2. The selling-prices of the houses are not higher than usual. That is possibel, because the ministries give subventions for planning and investment. Houses with traditional architecture are quite successful in the market, wooden houses or houses with modern design have more difficulties to be sold, especially in the old industrial regions. The buyers will save energy costs on a large scale if they use the solar houses in a right way. However, in Germany heating is not expensive, therefore people are not very motivated to save energy. The new tax for energy consumption will increase the price step by step. In contrast, the deregulation of the electricity market will cause a significant fall of electricity prices. The new special reguation for electricity produced by solar energy is very important. Every owner of solar pannels receives 99 DM for one KW electric power fed into the public electricity supply. We are optimistic in getting even better conditions for better conditions for solar estates. Concerning this question we have to look for partnership in Europe. In its "White Paper for a Community Strategy ans action Plan, Energy for the future: renewable Sources of Energy", the European Commission has formulated the "ambitious but realistic objective" of doubling the proportion of renewable energies by the year 2010 from 6 to 12%. Since march 2000 the project "50 Solar Energy Housing Estates" in North Rhine- Westphalia is part of the European "Campaign for Take-Off".

3. The first solar energy estates confirm the important part of cities and their local administation. Local authorities have to identify with solar projects and it is necessary,that in the local administration the diffrent competences work together.

4. Today solar energy estates are isles in the cities. The question is, how solar estates ans other solar projects can be weaved in a spiders web. I see two ways:
   - to build up a local network of all persons, groups and associations, who take part in solar projects, for empowerment of the actors, and at the same time,
   - to develop local aims and indicators for spreading use of solar energy.

The solar City project of the International Energy Agency is a good help on this way.

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Renewable Energies - Their Importance and Future in German Development Co-operation

Hans Peter Schipulle and Jörg Moczadlo

How important is energy for development?

At present, two billion people world-wide have no access to commercial energy supplies. In the poorest developing countries, people meet their energy needs by using firewood and other biomass. It is mostly women and children who have to walk for often hours to gather enough fuel to meet their basic needs. This not only limits their potential for economic development but also damages their health and, due to the enormous amount of time required, makes it difficult for them to gain access to information and education.

Energy is not only required for cooking and heating but is of great importance to economic development. In the newly industrialising countries, with their high degree of economic growth, energy deficiencies have often proved to be an obstacle to economic development and have forced these countries into second place behind the industrialised countries in the process of globalisation. Energy is, at the same time, both a factor of production and a branch of industry. Without energy as a production factor, economic development and the maintenance of a society's physical and social infrastructure would be inconceivable. As a branch of industry, energy supply contributes to an economy's added value, provides or creates jobs and is closely linked to all other sectors. Past and present experience in the industrialised countries has clearly shown that the availability of energy is a vital prerequisite for the development and prosperity of a society. Just how vital it is for an industrialised nation to have a constant supply of sufficient quantities of energy has been illustrated by the energy problems currently being experienced in California, where past mistakes in energy policy have resulted in intermittent power cuts of hours at a time, to the considerable detriment of the economy.

World energy supplies are based mainly on primary fuels such as coal and oil. According to the World Energy Assessment1 published in 2000, the demand for primary energy will, at best, increase by some 50% over the next 50 years and, at worst, by some 150% (cf. figure 1).

This can be attributed primarily to the sharp growth in the population and to the developing countries' need to make up lost ground in economic development. According to the Population Division of the UN Department of Economic and Social Affairs, the best case scenario is for the global population to have grown by 2050 by somewhere between 1 and 2 billion people, most of them in the developing countries, which are already home to around 80% of the world's population. The declared aim of the industrialised countries is to support the developing countries in their efforts to achieve stable economic growth in the framework of sustainable development. If a positive impact, or even only partial success, is achieved, the result will be an increasing demand for energy to maintain the new structures and the improved living standards created.

In the short term, it is unlikely that renewable energies will play a significant part in meeting the rising energy requirements of the developing countries, the main reason being that renewable energies are in many countries competing with conventional energy supply systems, which are capable of generating a large, and generally very reliable, supply of energy. What is more, these conventional technologies are often subsidised (e.g. coal), and external costs are not, as a rule, internalised. In many cases the prices charged do not even cover costs and the true price is obscured. Furthermore, experts agree that supplies of fossil fuels will last until the end of the 21st century and beyond. Given this situation, it is likely that many developing and newly industrialised countries will initially opt for conventional energy systems to meet their rapidly growing energy requirements.

We can therefore assume that, for decades

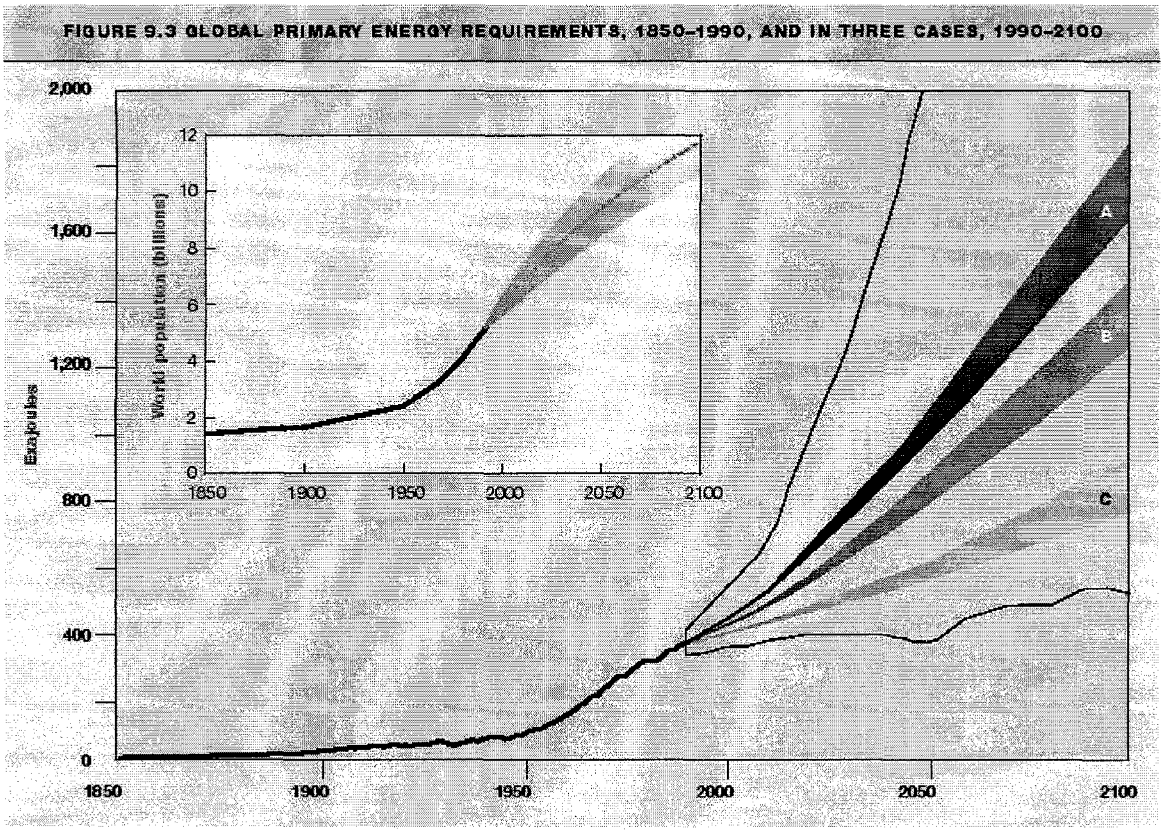

Figure 1: Historical and projected world energy requirements. Source: World Energy Assessment, 2000

to come, fossil fuels will play the greatest role in global energy supply.

The use of fossil fuels, however, causes local and global pollution, which compromises health and the quality of life and, in the long term, poses a threat to the ecological balance. The World Energy Council estimates that by 2050 global emissions of the greenhouse gas CO_2 will be double 1990 levels and that this increase will virtually all be due to growth in the developing countries. Whilst in 1990 developing countries accounted for less than 30% of world-wide CO_2 emissions, by 2050 this figure is likely to have risen to around 60%. According to a report recently published by the Intergovernmental Panel on Climate Change (IPCC), scientific evidence suggests that by 2100 the Earth's average temperature could rise by up to 5.8C and the sea level by up to 88 cm. These figures have been greatly revised upwards since the last report. The number of people dependent on the non-sustainable use of traditional fuels such as wood and other biomass is two billion and growing; in some regions of the Earth, this will increase the pressure on ecosystems as a result of deforestation and erosion.

In October 2000, the German government approved a climate protection programme that the government hopes will prompt a reduction in the greenhouse gas CO_2 by between 50 and 70 million tonnes by 2005. The aim is to help achieve the targets defined in the Kyoto Protocol on protecting the Earth's atmosphere, which was agreed in 1997 and to which the Federal Republic of Germany also committed itself.

What are the implications for German development co-operation?

Given the great importance of an adequate energy supply as a prerequisite for development, the Federal Ministry for Economic Co-operation and Development (BMZ) is therefore also concerned with the question of how to achieve economic growth that is at the same time environmentally sustainable. Within development co-operation, great importance is therefore attached to establishing a general framework and structures in developing countries that will give the people living there the opportunity for sustainable development. With this aim in mind, great efforts are being made to deliver an efficient supply of energy through conventional energy supply systems, to make rational use of energy supplies and to disseminate renewable energies. In identifying these activities as a priority area of German development co-operation, the main aim is to improve living standards by meeting basic energy needs, to alleviate poverty, to enhance developing countries' technological capacities in the energy sector, to reduce their dependence on energy imports and to support them in implementing the decisions made at the UN Conference on Environment and Development, especially the Framework Convention on Climate Change.

What role do renewable energies play in German development co-operation?

It is undisputed that, within a few decades, renewable forms of energies will be playing a major role in world-wide energy supply. Combining efficient use of traditional and renewable energies, such as biomass, solar power, wind, hydropower and geothermal energy, is becoming increasingly important in sustainable development. The World Energy Assessment concludes that, in a best case scenario for renewable energies, they would in 2100 account for between 70 and 80% of primary energy consumption (cf. figure 2).

There is an enormous pool of renewable energy immediately available for commercial use: untapped energy flows from renewable energy sources are far in excess of current world-wide energy consumption.

Yet if a sustainable supply of energy is to be established, clear parameters must be set, backed up by clearly focused sectoral policies dealing with such issues as efficient energy use, the application of environmentally-friendly energy technologies and the improvement of rural energy supply. These are the prerequisites for sustainability in the energy sector. With the global trend towards sector reforms and liberalisation, the role of the state has also changed in many developing countries. In an increasing number of countries, the state is no longer directly involved in the supply of energy but is, instead, responsible for creating a transparent framework. Many countries are still in the midst of this process of reform. This presents new challenges to the management capabilities of the state and its capacity to develop regulatory mechanisms that are in conformity with the market.

In view of this, German development co-operation advises the responsible government institutions in the partner countries on how to define their role and become more effective and efficient in performing their official duties, such as formulating policies and strategies, legislating, providing information, co-ordinating the sector and supervising and monitoring activities within it. Key tasks are the creation of a level playing field, improvements in the investment climate for the private sector and the introduction of cost-covering tariffs. In addition to the support provided at national level, advice is also given to international institutions on matters of regional integration, harmonisation of legislation and the identification of transnational projects.

Development co-operation is at the interface between energy policy and climate policy. One aim in this sector is therefore to promote the use of renewable energy installations connected to the grid, thus reducing the amount of CO_2 emitted through electricity generation. Both in Europe and, in particular, in the developing countries, there is enormous untapped potential for renewable energy installations connected to the grid. Today, renewable energies account for around 20% of the electricity generated world-wide; hydropower is at the fore, contributing around 19%. Indeed in some regions, such as Latin America, that share is a good deal higher. Over the next few years, increased use of wind power above all that will make an environmentally friendly and cost-efficient contribution to electricity generation and a reduction in greenhouse gases. However, solar thermal, geothermal and biomass-fired power plants are also sustainable options and are

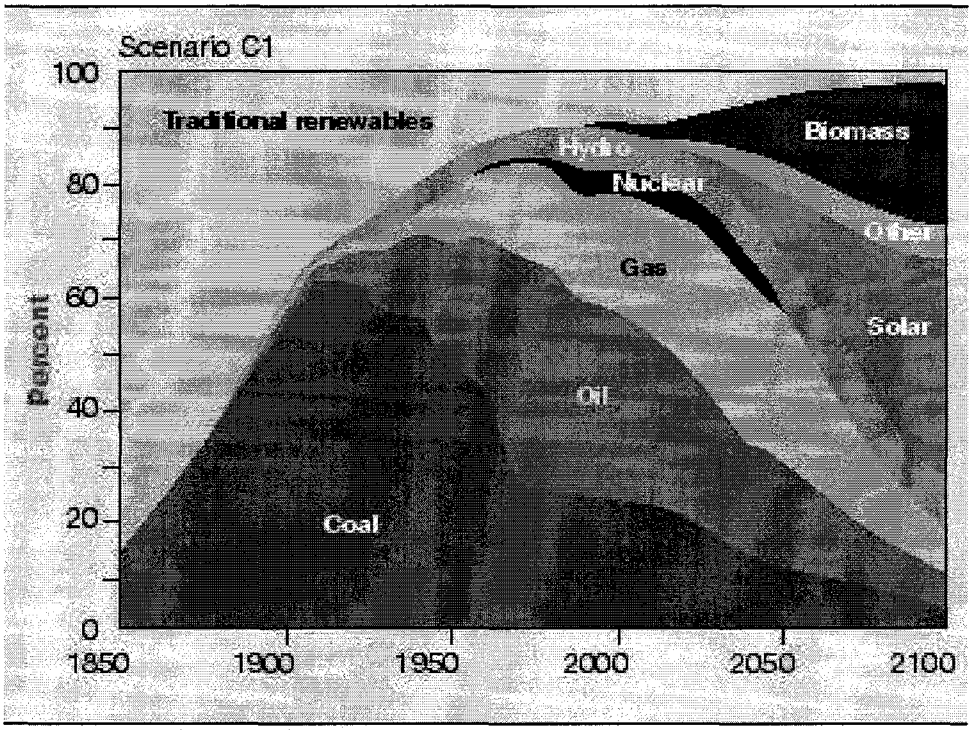

Figure 2: Energy usage by product. Source: World Energy Assessment, 2000

being promoted through German development co-operation. In 2000 alone, the BMZ has invested DM 200 million in renewable energies. Various development co-operation programmes exist at bilateral and multilateral level to support the identification, analysis, financing and implementation of projects of this kind.

The negative impact on environment and society of large dam-building projects has, over the last few years, increasingly resulted in a stand-off between investors and the people affected. The federal German government therefore supported the World Commission on Dams in its efforts to reach a consensus on evaluation criteria to prevent conflicts, avoid any negative impact on society and the climate and create a reliable climate for decision-making on hydropower use. The report's recommendations will be taken as guidelines for German development co-operation's support of hydropower projects.

The energy sector is not only of great relevance for climate policy, it is also plays an important role in poverty alleviation. The development of rural energy supply, in combination with other infrastructural measures such as water supply and transport links, plays a large part in improving the quality of life, securing the production base of the rural population and thus alleviating poverty. This makes the energy sector an integral part of poverty reduction strategies. Rural areas in the developing countries are usually far away from the energy grid and have decentralised supply structures. This makes them particularly suitable candidates for the use of renewable energy technologies, since these are often not only the sole option or the most environmentally friendly but also the cheapest.

Over the past few decades, a great many technologies, strategies for disseminating renewable energies and instruments for their promotion have been tested. The focus of development co-operation has therefore now shifted from demonstration programmes to broad-impact dissemination programmes. A major factor determining how economically sustainable these dissemination initiatives are is a high degree of conformity with market trends. For this to be achieved, it is vital for the local and international supply industry to be involved. Important programme components include securing the programme's place within energy policy, legislation and the taxation and customs regime; quality standards and quality control; establishment of financing mechanisms; training measures; public relations work; and, in financial co-operation, involvement in financing investment schemes. The following technologies in particular have proved their worth: small hydropower plants for small-scale grids, units for the efficient use or substitution of biomass, particularly for cooking, and installations for photovoltaic electricity generation (battery charging units and solar home systems for supplying individual households; electricity supply to facilities in the social infrastructure, such as rural health posts, schools, communication facilities; photovoltaic pumps for obtaining drinking water and small-scale irrigation).

If renewable forms of energy are to be popularised, a great deal of commitment and investment of capital is required. These challenges can clearly no longer be met by the state alone. German policy, therefore, is to involve other global players, such as grass-roots groups, international non-governmental organisations and also large and medium-sized companies, in development work and to appeal to them to shoulder their increased responsibility for building a sustainable world. It is therefore important to strengthen collaboration between official development co-operation and private enterprise. The BMZ thus promotes development partnerships with business so as both to enhance the effectiveness of development policy work and to provide support to the businesses in their involvement in the developing countries. The field of renewable energies is one that offers particularly good opportunities for co-operation; these should be seized for the benefit of the people in the developing countries and for the sake of the global climate.

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